



An exploration of the social and technological factors that drive Information and
Communication Technology adoption in Tasmanian dairy family farm businesses

By

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ABSTRACT

This thesis explores use of Information Communication Technology (ICT) on Tasmanian family owned dairy farms using a qualitative case-study approach. This research presents findings that contribute to an improved understanding of the social and technological factors influencing ICT use by Tasmanian dairy family farm businesses. The findings are discussed in relation to the Information Systems model TAM3 (Venkatesh and Bala, 2008) and an adapted model developed by the researcher.

ICT uptake in agriculture is continuing to be less than expected worldwide (Gelb and Voet, 2009; Alvarez and Nuthall, 2006; McBratney *et al.*, 2005; Lamb *et al.*, 2008). A key driver in improving farm performance is the provision and adoption of more efficient technologies and management practices (DAFF, 2005). Better understanding of human factors in the adoption of research in the agriculture and food industries is important to ensure intended research and development outcomes are achieved (DAFF, 2007). The main impediments to ICT adoption include lack of tailored ICT applications, their increased sophistication, which imposes enhanced human capital requirements, their lack of synchronisation with production, and the need for ongoing end-user training (Gelb and Voet, 2009; Alvarez and Nuthall, 2006). The factors identified as being associated with on-farm computer adoption include business size, education and age for example younger and better-educated farmers are more likely to adopt ICT applications (Alvarez and Nuthall, 2006). This thesis builds on the extensive literature base of cross-disciplinary research on adoption and innovation that has been developed over the past 50 years (Rogers, 2003; Rogers, 1983; Ruttan, 1996; Pannell *et al.*, 2006; Venkatesh and Bala, 2008) by undertaking an in-depth qualitative examination of the utilisation of ICT by dairy family farm businesses in Tasmania, taking a whole-farm holistic approach.

This research methodology employed a qualitative approach that was underpinned by a subjective ontology and an interpretative epistemology. The research strategy consisted of a case study using 33 individual farmers to acquire a rich data source from a broad range of farmers located in Tasmania, and six industry representatives servicing Tasmania. Thirty-three interviews were conducted with owners of family farm businesses and appropriate industries using semi-structured in-depth interviews. The questions were designed to gather the farmers' opinions, experiences and how they used ICT for business and personal

use, the impacts and problems associated with the use of ICT and background information about their business. Six industry interviews were conducted to provide an alternative lens in recognition that external factors, some of which farmers may not be aware of, are important, providing an alternative perspective for the research.

The farmer and the industry interviews were analysed separately using the same data analysis technique. This approach ensured any new industry insights in the Tasmanian dairy industry were revealed. The data collected was analysed systematically using thematic coding. The data was interpreted and discussed based on the researcher's understanding of the data and in relation to the available literature to allow for the key findings to emerge. The key findings for the research are as follows:

- *KF1 All generations of farmers are receptive or using smart-technology due to ease-of-use characteristics;*
- *KF2 Farmers place a high priority on lifestyle and family when making ICT decisions;*
- *KF3 Fragmented ICT investment is detrimental to long-term ICT utilisation;*
- *KF4 Globalisation of ICT use changes farming communities and farming practices;*
- *KF5 Industry has a key role to play in farmer-focused education on robotic systems.*

The key findings lead to the redevelopment of TAM3, placing significance on ease of use, and incorporating a complexity component to better explain the relationship between intention to use and actual use.

This research has made contributions to Information Systems knowledge at substantive, methodological and theoretical levels. At a substantive level, it has provided a case study of ICT use by Tasmanian dairy farmers and relevant industries, contributing to the understanding of factors influencing the use of ICT on everyday activities around the farm. This contributed to the understanding of lifestyle motivators, and the positive effect smart technology has had on ICT utilisation. At a methodological level this research has made a contribution by conducting a qualitative study of farmers' ICT use to provide in-depth understanding of the traditionally quantitatively researched field. At a theoretical level, the research has developed a revised TAM model that improves the explanation of the relationship between intention to use and actual use of ICT.

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TABLE OF CONTENTS

Abstract	i
Acknowledgements.....	iii
Table of Figures.....	ix
Table of Tables	xi
Chapter 1 Introduction	1
1.1 Introduction.....	1
1.2 Background.....	1
1.2.1 Industry	1
1.2.2 Family farm businesses	3
1.2.3 ICT	5
1.3 Research problem defined	7
1.3.1 Research aims	9
1.3.2 Research questions	9
1.3.3 Research approach.....	9
1.4 Contributions to knowledge	10
1.4.1 Substantive level	10
1.4.2 Methodological level.....	10
1.4.3 Theoretical level.....	11
1.5 Summary of following chapters.....	11
1.5.1 Chapter 2 – Literature review	11
1.5.2 Chapter 3 – Methodology	12
1.5.3 Chapter 4 – Analysis: Farmer perspectives on ICT use.....	12
1.5.4 Chapter 6 - Interpretation and Discussion	12
1.5.5 Chapter 7 – Overall Findings of the Research	12
1.5.6 Chapter 8 – Conclusion	13
1.6 Chapter reflections.....	13
Chapter 2 Literature Review	14
2.1 Introduction.....	14
2.2 Industry overview.....	14
2.2.1 Global agriculture.....	14
2.2.2 Australian agriculture.....	16
2.2.3 Tasmanian agriculture.....	17
2.2.4 Global dairy industry	17
2.2.5 The dairy industry in Australia	18
2.2.6 The dairy industry in Tasmania	22
2.2.7 Summary	25
2.3 Family farms and sociocultural diversity	26
2.3.1 The family farm business	26
2.3.2 Farm labour factors.....	29
2.3.3 Sociocultural diversity in farming: farming styles and subcultures.....	30
2.3.4 Summary	38
2.4 Information and Communication Technology (ICT) on the farm	38

2.4.1	ICT in Milking:.....	39
2.4.2	ICT for farm and herd management.....	43
2.4.3	ICT for communication and information.....	45
2.4.4	Summary	52
2.5	Adoption and use of ICT	52
2.5.1	Information Systems literature on adoption of ICT	53
2.5.2	Adoption and use of ICT by individuals and farming families	63
2.5.3	Summary	69
2.6	Chapter reflections.....	69
Chapter 3 Methodology.....		72
3.1	Introduction.....	72
3.2	Research framework	72
3.3	Research philosophy	73
3.3.1	Ontology.....	73
3.3.2	Epistemology.....	74
3.4	Research strategy	75
3.4.1	Qualitative research	75
3.4.2	A Case study approach.....	76
3.4.3	Boundaries of the study	77
3.5	Research design.....	78
3.5.1	Selection of farmers	79
3.5.2	Selection of Industry representatives	80
3.6	Data collection techniques	80
3.6.1	Farmer data collection	81
3.6.2	Industry data collection	87
3.7	Data analysis.....	90
3.7.1	Analysis	91
3.8	Trustworthiness and Researcher bias	99
3.9	Discussion and Interpretation	102
3.10	Model development.....	102
3.11	Chapter reflections.....	103
Chapter 4 Analysis: Farmer perspectives on ICT use		106
4.1	Introduction.....	106
4.2	Operational technology use	107
4.2.1	Pasture management.....	108
4.2.2	The hub	109
4.2.3	Herd management	111
4.2.4	Teething problems	113
4.2.5	Useability	115
4.2.6	Pie in sky.....	116

4.3	The Farmer	117
4.3.1	Personal challenge	117
4.3.2	Supporting rural communities	118
4.3.3	Conservation	119
4.3.4	Lifestyle	120
4.3.5	Generation	125
4.3.6	Grounding	128
4.3.7	Family farm	129
4.3.8	Technology adopters.....	133
4.4	Labour	134
4.4.1	Hard work.....	134
4.4.2	Trust relationships	135
4.4.3	Changing future.....	137
4.5	Practicalities	140
4.5.1	Infrastructure	141
4.5.2	Reliability.....	142
4.5.3	Complexity	145
4.5.4	Compatibility.....	146
4.5.5	Cost influence	147
4.5.6	Time consuming	148
4.5.7	Herd size.....	149
4.5.8	Capital limitations	150
4.5.9	Time saving	151
4.5.10	Financial recording.....	151
4.6	Exploring opportunities	152
4.6.1	Support	153
4.6.2	Industry not leading	153
4.6.3	Information seeking	154
4.6.4	Lacking driver	155
4.6.5	Convergence	156
4.6.6	Connected	157
4.7	Chapter reflections	160
Chapter 5	Analysis: Industry perspectives on ICT use	162
5.1	INTRODUCTION	162
5.2	financial	163
5.2.1	Cost benefit.....	163
5.2.2	Staff cost	165
5.3	Industry	166
5.3.1	Deregulation	167
5.3.2	Misled.....	169
5.3.3	Data and information	171
5.3.4	Education and skills.....	173
5.3.5	Design and support	175
5.3.6	Green	177
5.4	Lifestyle	177

5.4.1	Advocate	178
5.4.2	Futuristic	180
5.4.3	Next generation	181
5.4.4	Mindset	181
5.4.5	Lifestyle	182
5.5	Operational.....	183
5.5.1	Animals first	183
5.5.2	Information	184
5.5.3	Robots	187
5.5.4	Staff	188
5.5.5	Herd size.....	189
5.5.6	Useability	189
5.5.7	Under utilised.....	190
5.6	Technology	190
5.6.1	Convergence	191
5.6.2	Design.....	193
5.6.3	NBN	193
5.6.4	Connection	194
5.6.5	Trust	195
5.6.6	Reliability.....	196
5.6.7	Technology failing	196
5.7	Chapter reflections.....	197
Chapter 6 Interpretation And Discussion.....		200
6.1	Introduction.....	200
6.2	Preliminary findings.....	201
6.2.1	ICT used to interact with the community anytime, anywhere.....	201
6.2.2	ICT changing the way information is sourced	205
6.2.3	ICT and herd management.....	207
6.2.4	Infrastructure essential	216
6.2.5	Industry complexity and compatibility factors.....	218
6.2.6	ICT and the next generation.....	220
6.2.7	Healthy work environment'	222
6.2.8	Lifestyle as a priority	225
6.3	Chapter reflections	227
Chapter 7 Overall Findings of the Research		228
7.1	Introduction.....	228
7.2	Research key findings	228
7.2.1	All generations of farmers are receptive to or using smart-technology due to ease-of-use characteristics (KF1)	228
7.2.2	Farmers place a high priority on lifestyle and family when making information and communication technology decisions (KF2).....	230
7.2.3	Fragmented ICT investment is detrimental to long-term ICT utilisation (KF3)	231
7.2.4	Globalisation of ICT use changes farming communities and farming practices (KF4).....	232
7.2.5	Industry has a key role to play in farmer-focused education on robotic	

systems (KF5)	234
7.2.6 Summary of key findings	235
7.3 Model development	235
7.4 Chapter reflections	246
Chapter 8 Conclusion	248
8.1 Introduction	248
8.2 Summary of key findings	248
8.2.1 RQ sub 1:	249
8.2.2 RQ sub 2:	250
8.2.3 RQ sub 3:	252
8.3 Research contributions	253
8.3.1 Substantive level	253
8.3.2 Methodological level	254
8.3.3 Theoretical level	254
8.4 Recommendations for industry	255
8.5 Research limitations	256
8.5.1 Scope of research	256
8.5.2 Researcher bias	257
8.5.3 Lack of generalisability	258
8.6 Future research	258
8.7 Concluding reflections	259
References	260
Appendix 1 : Farmer interview framework	273
Appendix 2 : Industry interview framework	276
Appendix 3: Seasonality of milk production by state	278

TABLE OF FIGURES

Figure 1-1 Location of research within broader discourses	7
Figure 2-1 Dairy Farming regions.	18
Figure 2-2 Monthly national milk production (million litres).	21
Figure 2-3 Seasonality of milk production in Tasmania 2011/2012 (million litres).	23
Figure 2-4 Maximum cows milked per herd for more than 3 months.	23
Figure 2-5 Positive attitudes to industry future by region (% farms).	25
Figure 2-6 Three year growth outlook by region.....	25
Figure 2-7 Farming styles in Friesian dairy farming.....	31
Figure 2-8 Operationalisation of style for an individual farm.	34
Figure 2-9 Schematic diagram explaining how DAFS are identified and interpreted.....	35
Figure 2-10 Example of a Herringbone shed.	41
Figure 2-11 Rotary Dairy.....	42
Figure 2-12 Automation by shed type,.....	42
Figure 2-13 Telstra mobile network coverage – data.....	46
Figure 2-14 Growth of mobile-only users by age group in Australia.....	47
Figure 2-15 Access to the Internet.	49
Figure 2-16 Devices used to access the Internet.....	50
Figure 2-17 Theory of Reasoned Action.	54
Figure 2-18 Theory of Planned Behaviour.....	56
Figure 2-19 TAM.	57
Figure 2-20 TAM2	57
Figure 2-21 TAM3	58
Figure 2-22 Unified Theory of Acceptance and Use of Technology UTAUT	60
Figure 2-23 UTAUT2	62
Figure 3-1 Research framework	73
Figure 3-2 Graph of location of all Tasmanian Dairy Farmers	79
Figure 3-3 Location of farms visited during data collection	80
Figure 3-4 Data Reduction of Transcripts using NVivo 9.	93
Figure 3-5 Screen shot from NVivo showing coding from the transcripts	94
Figure 3-6 Summary of 32 farmer themes grouped into five clusters.	104
Figure 3-7 Summary of the 27 industry themes grouped into five clusters.....	104
Figure 4-1 Summary of 32 farmer themes grouped into five clusters.	161

Figure 5-1 Summary of the 27 industry themes grouped into five clusters.....	198
Figure 7-1 Proposed adapted TAM3 model based on research	236

TABLE OF TABLES

Table 2-1 Australian dairy industry farm statistics by state for the year 2011/2012.	19
Table 2-2 Financial estimates - Australian dairy farms, by region, average per farm.	24
Table 2-3 Farming Styles by researchers summarised	32
Table 2-4 Twenty-seven farming styles.	32
Table 2-5 Reconceptualising farming styles	33
Table 2-6 Overview of attitudinal characteristics of each DAFS group.	35
Table 2-7 Description of 'styles'.	37
Table 2-8 Growth in the 12-month period to December 2012	48
Table 2-9 Internet subscribers by type of access connection.	48
Table 2-10 Barriers to engagement of Internet services.	52
Table 2-11 Perceived Usefulness determinants for TAM2	58
Table 2-12 Perceived Ease of Use determinants	59
Table 2-13 UTAUT determinants and moderators	61
Table 2-14 UTAUT2 determinants and moderators.	61
Table 2-15 Studies of relationships between adoption index and selected variables.	64
Table 2-16 Factors influencing the adoption of PATs.	66
Table 3-1 Demographics of farmers interviewed	81
Table 3-2 Demographics of farms interviews.	83
Table 3-3 Description of Industry interviewed	88
Table 3-4 Examples of Data Reduction.	95
Table 3-5 Abstraction of Summary Codes to conceptual labels.	96
Table 3-6 Grouping of Conceptual Labels to produce Themes.	97
Table 3-7 Example of grouping of themes into Clusters by theme concept.	98
Table 3-8 Summary of LABOUR Cluster	99

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This thesis explores the use of Information Communication Technology (ICT) on Tasmanian family farm businesses. This chapter provides an introduction to the research and presents the research problem and research questions. It introduces the contributions the research makes to Information Systems (IS) knowledge through the improved understanding of the social and technological factors affecting the use of ICT on Tasmanian family farm businesses. The chapter is divided into the following sections:

- Section 1.2 outlines the background to this research and outlines the conceptual framework in which this research was conducted. This research lies within the intersection of three domain areas – the agricultural industry, family farm businesses and ICT adoption;
- Section 1.3 introduces the research problem, the aims, questions and objectives. ICT uptake in agriculture is less than expected worldwide, and suggests that a better understanding of the human factors of the adoptions of ICT is needed;
- Section 1.4 presents a summary of the contributions to Information Systems knowledge contributed by this research at substantive, methodological and theoretical levels;
- Section 1.5 provides an overview of the structure of the thesis, outlining the remaining chapters;
- Section 1.6 provides a summary of the chapter

1.2 BACKGROUND

1.2.1 Industry

Agriculture has a very positive future sustained by rising global demand for agricultural products (Godfray *et al.*, 2010; Cribb, 2009). This is driven by factors such as population growth (Lutz and Samir, 2010), increasing wealth in developing economies, shifts in

consumption patterns and demographic change (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012). Agricultural production needs to increase by 60% over the next 40 years to meet the rising demand for food, yet globally the scope for expansion of areas under cultivation is limited. Total arable land is projected to increase by only 69 Mha (less than 5%) by 2050. Additional production will need to come from increased productivity in the same way as it has for the past 50 years (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012).

Agriculture will be the next industry to benefit significantly from Asia led growth. Australia and New Zealand (NZ) stand to capture an additional Australian \$0.7-1.7 trillion and New Zealand \$0.5-1.3 trillion respectively in agricultural exports between now and 2050, however this growth will not happen of its own accord. Maximising growth will require Australia and NZ to overcome a broad range of barriers including capital constraints, skill shortages, land-use conflicts, and inefficient water markets, unfocused R&D and extension services, rising supply chain costs, and market access limitations (Port Jackson Partners, 2012). A key driver in improving farm performance is the provision and adoption of more efficient technologies and management practices (DAFF, 2005). Improved technologies and better management practices are important investments for dairy farmers in order to avoid declining real farm incomes. Most Australian dairy farms made at least one innovative change over the two years ending 2007-2008 (Liao and Martin, 2009). An overview of agriculture in a global context is provided in section 2.2.1, and domestically within Australia in section 2.2.2. Section 2.2.3 provides an overview of agriculture in relation to Tasmania.

The national dairy herd in 2012/2013 is comprised of 1.65 million cows, producing 9.2 million litres in total per year (Dairy Australia, 2013a). The average herd size is 247 cows, with an annual milk production per cow of 5,891 litres (Dairy Australia, 2013a). An overview of the dairy industry globally, in Australia and in Tasmania is provided in sections 2.2.4 to 2.2.7. There are two sectors to the Australian Dairy Industry – the fresh milk sector, and manufacturing and export sectors. The fresh milk sector supplies drinking milk to the human population. To ensure a stable supply, the farmer is paid more to produce milk in the expensive winter months. All of Australia's states have dairy industries that supply fresh drinking milk to cities and towns nearby. Australia's milk production is seasonally based, with large quantities of milk produced during spring when the main source of cow feed – pasture, is in biggest supply. The excess milk produced at this time is

utilised in the manufacturing sector with the produce either sold locally or internationally. The Australian dairy industry operates in a deregulated and open environment, and has done so for over a decade. Therefore international markets and prices are the major factors determining the price received by farmers for their milk. Globally, Australia's dairy exports total \$2.75 billion, which is 8% of the world dairy trade. Australia currently ranks fourth in terms of world dairy trade – behind New Zealand (34%), the European Union as a block (34%) and the United States (11%) (Dairy Australia, 2011a).

The state of Tasmania occupies a land area of 68,300 square kilometres, of which nearly a third is committed to agriculture. Tasmania is a highly rural and regionalised state with approximately 60% of its population of 500,000 living outside its capital, Hobart (Department of Health and Human Services, 2008). Tasmania is a growth state for dairy farming in Australia (Dairy Australia, 2011a). The dairy industry in Tasmanian is considered to have excellent expansion opportunities compared to other states in Australia due to irrigation expansion opportunities and the natural climate. Tasmania's 444 dairy farms account for approximately 8% of national milk production, with the average herd size being 327 cows. The Tasmanian dairy industry is the most seasonal of all states and milks the greatest peak number of cows per farm in Australia (Dairy Australia, 2012a). The seasonality of Australian dairy production by state is shown graphically in Appendix 3. The seasonality is due to milk production being largely based around the seasonal pasture growth curve, supplemented with irrigated pasture and crops, in comparison to Victoria, which has access to cheap grain to supplement the cows' diet. This large seasonal peak, and minimal requirements for drinking milk due to the small Tasmanian population, means Tasmania has a large peak surplus production providing the opportunity for over 40% of Tasmania's milk production to be exported (Bills, 2013).

1.2.2 Family farm businesses

*Farm family businesses are distinctive; they behave in different ways from non-family businesses, because they are **family** businesses. By the same token farm families differ from other types of families, even families running other businesses, because they run **farm businesses**. (Errington and Gasson, 1993 p. 23)*

Family farming has been and still is the backbone of Australian agriculture (Vanclay and Fulton, 2011 p. 95). Ninety-eight per cent of Australian dairy farms are family owned; two per cent are corporately owned, and 90% are family-operated businesses (Dairy Australia,

2011b). The dairy farm in Australia varies from a basic subsistence mode through to commercially smart, automated, integrated corporations. Hence a better understanding of human factors in the adoption of research in the agriculture and food industries is important to ensure intended research and development outcomes are achieved (DAFF, 2007).

The farm family business is essentially a flexible organisation. The interweaving of family relationships with business objectives gives it a resilience, tenacity and durability, which enables it to respond to internal and external pressures, which could break non-family businesses. Family farms behave in a business orientated way, however their decision making processes are more complex with decisions being made within a multifaceted framework. This framework embraces intrinsic values in farm work, the values of autonomy and family continuity as well as maximising profitability (Vanclay, 2004; Gasson *et al.*, 1988; Hutson, 1987; Reinhardt and Barlett, 1989).

The prime objective for many family businesses is not profit maximization but succession, the desire to maintain control and to pass on a secure and sound business to the next generation (Errington and Gasson, 1993). This may be inter-generational, so short-term profitability may be sacrificed for longer-term growth. Farmers with children who are coming into the business, or who they are trying to encourage into the business may be prepared to take on heavy financial commitments at a time when non-family farms might be consolidating rather than expanding. This is explained further in section 2.3.1.

Business objectives are likely to change over the stages of the family cycle, reflecting the age of the farm operator and the importance of family needs at differing stages (Vanclay and Fulton, 2011; Gasson *et al.*, 1988). The early phase of a family cycle typically consists of a young couple and no children past school leaving age, where family demands are high, and the young couple is energetic. This generally coincides with the establishment and growth phase of the farm. In the middle phase family members especially the children may seek off-farm work, develop other enterprises within the framework of the farm business, or remain home possibly to avoid being unemployed. The late phase of the family cycle is where there are lower family needs, and less energy from the parents (Gasson *et al.*, 1988 p. 96). Older farmers may be more concerned with minimising losses than with maximising profits, preferring to save rather than invest and expand. The process of succession, the gradual transfer of control from one generation to another, has always been significant in family farming. The presence of a successor may have more influence upon business

objectives and farm performance that the farmer's age (Errington and Gasson, 1993). A successor provides a constant incentive for forward planning and expansion reducing the likelihood of the business becoming rundown and the capital consumed, if only to reduce workload.

The definition of a family farm business by Gasson *et al.* (1988) prioritises family and business components and gives little prominence to the farm as a physical entity. Vancley and Fulton (2011 p. 97), suggest that there is a strong relationship between the family and the land. They also propose that there is a strong link between the economic success of the business and the farm's natural resources and biophysical constraints (p. 97).

1.2.3 ICT

Using or not using (ICT) is no longer an issue. The appropriate questions are rather: who uses ICT, how do they use it, and for what (Csoto, 2011 p. 262)

A personal computer (PC) is a descendant of the IBM Personal Computer, first released to the public in 1981 (IBM, 2014). The other two important minicomputer release dates are the Apple II (1977), and the Macintosh or Mac (1984). Both are produced by Apple computers (Macworld, 2006). A major key to the PC's success was its affordability to a mass market. The development that revolutionised PCs and which is an integral part of personal computing in general is the graphical user interface or "point-and-click" approach which was first used by Macs (Management Today, 2014), but revolutionised PCs when Windows was developed. Windows was introduced in 1985, and like the Macintosh, its graphical user interface performs functions by connecting to the Internet (Microsoft, 2013). Windows has gone through numerous revisions. Windows 8 is the current version.

Mass use of mobile devices, handheld devices or personal digital assistants (PDAs) did not occur until Martin Cooper of Motorola obtained a patent for cellular handset technology in 1975. Until the mid-1990s, mobile devices were categorised as either communication oriented (e.g. cell phone) or information (e.g. PDAs, Palm Pilot and Pocket PC). Over the past two decades, the difference between the two categories has been blurred. The latest smart phones have enhanced user interfaces and use 3G or 4G networks to reach the Web from virtually anywhere and are a direct result of users' strong desire to always stay connected. The promise of mobile computing has been fulfilled through integration with Web technologies and content (Vu and Proctor, 2011). New interaction models enabled by advanced touchscreen technologies have allowed end users to access many applications

usually referred to as apps for these phones to perform many practical day-to-day tasks such as to check the weather or to do Internet banking. Mobile apps are software-based tools that can be downloaded and installed on a smartphone or tablet to enhance the device's functionality. Smartphones now have powerful and efficient processors, modern operating systems, broadband Internet access and user-friendly interfaces and productivity enhancing apps (Wang *et al.*, 2014). The availability of cheap embedded sensors, an open and programmable environment, new applications from app stores and mobile computing cloud services has promoted the current dominance of smartphones (Lane, 2012). A rich set of sensors embedded in smartphones enables new applications across a wide variety of domains like homecare, healthcare, social networks, safety, environmental monitoring, e-commerce and transportation (Khan *et al.*, 2013). In Europe, uptake of phones has continued to increase rapidly with six in ten adults now claiming to own one (61%), (OFCOM, 2014 p. 3).

Wireless cellular networks play a significant role in sensing and monitoring for both human-interfacing devices such as smartphones and machine-to-machine devices as they provide connectivity and mobility. Embedded mobile sensors and their associated services depend on wireless networks to offload their data to back-end servers in the cloud. The cloud provides unprecedented scalability and resources for the collection and analysis of large-scale sensor data. Cloud services are likely to play a large role in sensing and monitoring as they provide computing capabilities and storage capacities not yet available on the sensor devices themselves. Computerised information systems can potentially help the dairy producer to deal with the increased complexity of decision-making and the availability of information in dairy farming. These systems should be fully integrated to ensure a coordinated execution of dairy farming activities (Pietersma *et al.*, 1998).

Rapid expansion of broadband capabilities into rural and regional Australia for national coverage is important for information exchange in agricultural and natural resource management extension (Hunt *et al.*, 2012). The Internet has provided a way for farmers to passively access information using websites, and more recently YouTube, which may be used for personal or family use, or business use to watch industry presentations such as information videos.

Social media is also beginning to gain recognition by farmers and industry representatives and companies as a tool for use in the Australian rural sector. Social media is going to be critical in regional Australia for innovation (Higgins, 2011). Some researchers have found

that farmers' participation in social and commercial networks is an important driver of innovation in rural areas (May, 2011). Regional Australia has the ability to increase significantly its levels of innovation in the areas of community, business and technology by using social media to drive participation and then use it to assist with change on the farm. The ability to do so will improve as Internet connections improve. Without this opportunity, there will be a widening gap between the innovative capacities of major cities and regional areas because of the difference in the range of interactions that can occur (Higgins, 2011).

As such, the research space that this thesis describes lies in the intersection between three areas: 1. Tasmanian dairy industry; 2. Tasmanian dairy family farm businesses; and 3. ICT (Figure 1-1). This research contributes to these three domains. This research contributes to an improved understanding of the social and technological factors influencing ICT use by Tasmanian dairy family farm businesses.

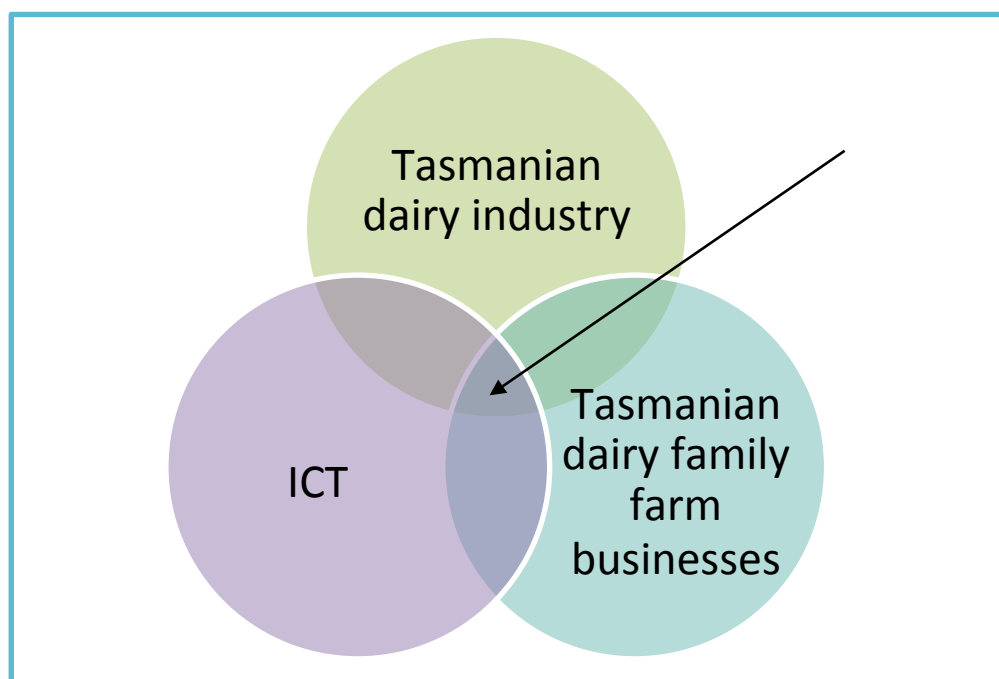


Figure 1-1 Location of research within broader discourses

1.3 RESEARCH PROBLEM DEFINED

This thesis explores the social and technological factors that drive ICT adoption in Tasmanian dairy family farm businesses from the dual lens of the farmer and associated industries using a qualitative case study approach.

ICT uptake in agriculture is continuing to be less than expected worldwide (Gelb and Voet, 2009; Alvarez and Nuthall, 2006; McBratney *et al.*, 2005; Lamb *et al.*, 2008; Csoto, 2011). A key driver in improving farm performance is the provision and adoption of more efficient technologies and management practices (DAFF, 2005). A better understanding of human factors in the adoption of research in the agriculture and food industries is important to ensure the intended research and development outcomes are achieved (DAFF, 2007). The main impediments to ICT adoption have been suggested to include lack of tailored ICT applications, their increased sophistication, which imposes enhanced human capital requirements, their lack of synchronisation with production, inappropriate information for the end user and the need for ongoing end-user training (Gelb and Voet, 2009; Alvarez and Nuthall, 2006; Car *et al.*, 2012). The factors identified as being associated with on-farm computer adoption include business size, education and age for example younger and better-educated farmers are more likely to adopt (Alvarez and Nuthall, 2006).

The use of robotic milking systems (AMS) in Australia has been low to date (de Koning, 2010b; Svennersten-Sjaunja and Pettersson, 2008). Reasons for the limited uptake in Australia include larger farm sizes and the focus on pasture-based grazing systems, which add complexity to management with AMS (Eastwood and Kenny, 2012). Interest is growing in combining AMS with pasture-based systems in Europe, Australia and New Zealand. Few researchers have explored this area (Jacobs and Siegford, 2012). Specific reasons for adoption include attracting the younger generation into farming through farm succession through the use of technology. New technologies provide many advantages for the younger generation. A major advantage is the ability to attract and retain better quality labour because the routine of milking is less physically demanding. This is beneficial for older farmers and those with health issues (Kerrisk and Ravenhill, 2011; Kerrisk and Ravenhill, 2010; de Koning, 2010a). Globally it is predicted that by 2016, 22% of all dairy farms and 18% of all dairy cows will be milked under Automatic Milking Systems (AMS) (Ron Mulder 2012, Tasmanian Dairy Conference). In Australia, it is predicted there will be 41-89 AMS installations in five years. This is 5-10% of the new dairy infrastructure (Kenny and Eastwood, 2011).

This thesis builds on the extensive literature base of cross-disciplinary research on adoption and innovation that has been developed over the past 50 years (Rogers, 2003; Rogers, 1983; Ruttan, 1996; Pannell *et al.*, 2006; Venkatesh and Bala, 2008) by undertaking an in-depth qualitative examination of the utilisation of ICT by dairy family farm businesses in

Tasmania, taking a whole-farm holistic approach in recognition of the importance of the situational context of the user.

1.3.1 Research aims

The aim of this research is to explore the social and technological factors that drive ICT adoption in Tasmanian dairy family farm businesses. This includes examining why farmers choose to interact or not interact with ICT from a dual lens of the farmer and industry.

1.3.2 Research questions

The following research questions and sub-questions are designed to meet the aims and research problem of this study:

RQ What are the social and technological factors that drive ICT adoption in Tasmanian dairy family farm businesses?

RQ sub 1: How do family farm businesses interact with ICT?

RQ sub 2: How do family farm businesses attitudes and experiences influence the uptake of ICT?

RQ sub 3: How is industry influencing technology uptake in Tasmanian dairy farms?

1.3.3 Research approach

This research methodology employs a qualitative approach that is underpinned by a subjective ontology and an interpretative epistemology. The research strategy is a case study using 33 individual farmers to acquire a rich data source from a broad range of farmers located in Tasmania and six dairy industry representatives servicing Tasmania. Thirty-three interviews were conducted with owners of family farm businesses and appropriate industry using semi-structured in-depth interviews. The questions are designed to gather the farmers' opinions, experiences and how they used ICT for business and personally, the impacts and problems associated with the use of ICT and background information about their business. Six industry interviews were conducted to provide an alternative lens in recognition that external factors are important to provide an alternative perspective for the research.

The farmer and industry interviews were analysed separately but using the same data analysis technique. This approach ensured any new industry insights in the Tasmanian dairy industry were revealed. The data collected was analysed systematically using thematic coding. The data was interpreted and discussed based on the researcher's understanding of the data and in relation to the available literature to allow for the key findings to emerge.

1.4 CONTRIBUTIONS TO KNOWLEDGE

This research has made a number of contributions to Information Systems knowledge at substantive, methodological and theoretical levels.

1.4.1 Substantive level

At a substantive level this research has provided a rich case study of the use of Information Communication Technology (ICT) on dairying family farm business in Tasmania. Dairy farming was selected exclusively due to the fact that dairy farming is the most intensive of the grazing animal production system in Australia, and therefore it has the most opportunity for ICT to have a significant effect on the industry. Tasmania has the largest average herd size of all the states in Australia. This larger herd size is an indication of the trend Australia wide, and makes Tasmania an industry relevant location to conduct the study (section 2.2.6). Thirty-three small, medium and large farms were selected from all dairying regions of Tasmania, (Section 3.4.2).

1.4.2 Methodological level

At a methodological level this research contributes significantly in two ways. Firstly, historically agricultural research as well as broad innovation adoption, acceptance and diffusion research has been predominantly empirical and quantitative in nature (section 3.4.1). This research used a qualitative approach to facilitate a comprehensive integrated systems understanding of family farm businesses' use of ICT. This approach recognises the importance of the situational context that surrounds farmers' use of ICT. The view that such research is needed is supported by DAFF (2007) who identify that better understanding of human factors in the adoption of research in the agriculture and food industries is important to ensure that the intended research and development outcomes are achieved. A review of literature concerning the adoption of ICT in agriculture (section 2.5.2.2) found the majority of the studies to be survey and quantitative in nature (Gelb and Voet, 2009; Alvarez and Nuthall, 2006), which is reflective of broad innovation, adoption,

and acceptance and diffusion research. Williams *et al.* (2009) conclude innovation adoption, acceptance and diffusion research over a 22 year period is predominantly empirical and quantitative, revealing clear opportunities for researchers to make original contributions by making greater use of theoretical and methodological variety. Tey and Brindal (2012) conclude that current models in the approach are not sufficient to represent the totality of recent research considerations, which lead to the adoption of Precision Agricultural Technologies. Past studies largely ignore the informational, behavioural, and social aspects of decision making. Secondly, in addition to the qualitative focus on family farm businesses, industry interviews were used to provide an additional perspective and lens on the research (Section 3.4.2).

1.4.3 Theoretical level

At the theoretical level, this research is informed by a social perspective on TAM3 (section 2.5.1.3), and critiques its relevance to the family farm dairy business in Tasmania. A model expanding the determinants of individual ICT adoption and use was developed for the agricultural sector (section 7.3). Analysis of the data revealed that the image was not a determinant of perceived usefulness. Additionally the relationship between behavioural intention of use and actual use behaviour was better predicted with inclusion of a complexity determinant reflecting impact of system compatibility (Section 7.3.1.14).

1.5 SUMMARY OF FOLLOWING CHAPTERS

This section provides an overview of the remaining chapters in this thesis.

1.5.1 Chapter 2 – Literature review

Chapter 2 provides an overview and critique of the core literature in the three key domain areas of relevance to this research. In section 2.2 an industry overview is provided. Agriculture and the dairy industry are explored from a global, Australian and Tasmanian perspective. Section 2.3 provides a review of the unique considerations surrounding operating a family farm business. The sociocultural diversity of the family farm business is then discussed, incorporating a discussion of farming styles. Sections 2.4 and 2.5 review ICT used by the dairy farmer, ICT adoption models and agricultural adoption studies. Each section of the literature review includes a summary containing an explanation of where this study is making a contribution to the literature (sections 2.2.7; 2.3.4; 2.4.4 and 2.5.3).

1.5.2 Chapter 3 – Methodology

Chapter 3 examines in detail the methodological approach of this research. The chapter describes the philosophical stance adopted, the research strategy, the research design, and the tools and techniques used to carry out the research design. The chapter describes the method of data analysis used in this research, and outlines the approach to the interpretation and discussion of the research.

1.5.3 Chapter 4 – Analysis: Farmer perspectives on ICT use

Chapter 4 provides an analysis of the data collected from semi-structured interviews of 33 farmers. The data is analysed drawing on the principles of thematic coding guided by open coding. The chapter presents 32 themes that are grouped into five clusters.

Chapter 5 – Analysis: Industry perspectives on ICT use

Chapter 5 provides an analysis of the data collected in semi-structured interviews with six Industry representatives. The data collected from the Industry interviews provides an alternative lens in recognition that external factors that farmers may not be aware of are important to the current and future use of ICT on farms. The data is analysed drawing on the principals of thematic coding guided by open coding. This chapter presents five clusters of themes derived from the semi-structured interviews that constituted the data for the industry component of this research. The themes are presented and justified with extracts from the transcripts of the audio recordings from the semi-structured interviews.

1.5.4 Chapter 6 - Interpretation and Discussion

Chapter 6 distils the themes from Chapters 4 and 5 into eight overarching preliminary findings, and discusses these in relation to the available literature.

1.5.5 Chapter 7 – Overall Findings of the Research

Chapter 7 presents the five key findings, which have emerged from the interpretation and discussion of the eight preliminary findings. These key findings are presented along with an interpretation and discussion in relation to the available literature. The research is then discussed in relation to the Information Systems model TAM3, and an adapted model presented.

1.5.6 Chapter 8 – Conclusion

Chapter 8 provides a summary of the key findings and addresses the research question by answering the three sub-research questions. It also provides a discussion about the contributions this research has made at a substantive, methodological and theoretical level. This chapter makes recommendations to the industry and highlights the limitations of the research. The chapter then suggests possible future research in this area.

1.6 CHAPTER REFLECTIONS

This chapter provides the background to this research. The research problem is discussed together with the research question and research sub questions. The contributions of this thesis are at three levels, theoretical, substantive and methodological. This chapter concludes with a summary review of the remaining chapters in the thesis.

The next chapter provides a review of the literature relevant to this thesis.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides a review of the literature in the three key domain areas relevant to this research: Tasmanian family dairy farms and sociocultural diversity; adoption and use of ICT; and ICT on the farm. It is divided into the following sections:

- Section 2.2 provides industry background. Agriculture and the Dairy Industry are explored from a global, Australian and Tasmanian perspective. Section 2.2.7 summaries the section and describes the studies' contribution to the literature;
- Section 2.3 provides a review of the unique considerations surrounding operating a family farm business. The sociocultural diversity of family farm businesses is then discussed, incorporating a discussion of styles of farming, and farming subcultures. Section 2.3.4 summaries the section and discusses the studies' contribution to the literature;
- Section 2.4 provides a review of studies of on-farm ICT use, and other relevant studies on ICT use in the wider community. The influence ICT has had on how farmers research and gain information is discussed. Section 2.4.4 summaries the section and discusses the studies' contribution to the literature;
- Section 2.5 provides an overview of adoption and use of ICT. Information systems literature on adoption of ICT is discussed, followed by a section on adoption and use of ICT by individuals and farming families. Section 2.5.3 summaries the section and discusses the studies' contribution to the literature;
- Section 2.6 provides a summary reflection of this chapter.

2.2 INDUSTRY OVERVIEW

2.2.1 Global agriculture

Agricultural trade history has been diverse. For settler states like Australia the period between 1870 and 1914 centred on the export of meats and grains to Europe, in exchange for capital and manufactured goods. After the First World War, a power shift to America resulted in an American model of agri-food industrialisation, which centred on

developments in energy and nitrogen, followed by genetics in the 1930s, allowing agribusiness firms to link farming with industrial inputs (Mooney, 1986). Regulation in the USA driven by farmers to protect their markets encouraged dramatic drops in prices of beef. The second global food regime was characterised by institutionalised over-production supported by state interventions to furnish urban populations with cheap food while guaranteeing farm incomes and disposing of surplus farm production. In the three decades following 1945, rapid expansion of international transnationals such as Heinz, Kellogg, Nestle, and Unilever occurred. In the 1980s farm gate prices fell with rationalisation of basic processing and input industries. Recently, economic power has shifted to the retailing sector through promotion of retailer brand labels and generics, which control food processors' margins (Marsden and Wrigley, 1995).

Agriculture has a very positive future sustained by rising global demand for agricultural products (Godfray *et al.*, 2010; Cribb, 2009). This is driven by factors such as population growth (Lutz and Samir, 2010), increasing wealth in developing economies, shifts in consumption patterns and demographic change (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012). The challenges to the world's ability to produce food include decreasing fisheries, biofuel production, global water crisis, land scarcity and soil degradation (Cribb, 2009). Increased global agricultural commodity price projections are due to higher oil prices and the competition for stockfeed by the biofuels industry (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012). Developing countries because of their greater potential to increase land devoted to agriculture and to improve productivity, will provide the main source of global production growth in the next ten years (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012). Rising incomes and dietary changes of people will favour higher value meats and dairy products and drive the indirect demand for coarse grains and oilseeds for livestock feed (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012).

The key issue facing global agriculture is how to increase productivity in a more sustainable way (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012). Agricultural production needs to increase by 60% over the next 40 years to meet the rising demand for food, yet globally the scope for expansion of areas under cultivation is limited. Total arable land is projected to increase by

only 69 Mha (less than 5%) by 2050. Additional production will need to come from increased productivity in the same way as it has for the past 50 years (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012).

2.2.2 Australian agriculture

There are approximately 134,000 farm businesses in Australia, 99% of which are family owned and operated. As of 2010-11, there are 307,000 people employed in Australian agriculture. The complete agricultural supply chain, including the affiliated food and fibre industries, provide over 1.6 million jobs to the Australian economy (National Farmers' Federation, 2012), with 15% of the Australian workforce involved in food production (DAFF, 2013).

Australia currently produces enough agricultural product to feed 60 million people, three times its population, with Australian farmers producing almost 93% of Australia's daily domestic food supply, and exporting 60% (in volume) of what they grow and produce (PMSEIC, 2010). Export earnings from farm commodities was estimated to be \$36 billion in 2010-11, 2% of Australia's GDP. Australia's major agricultural commodities are as follows (in order of value): wheat, beef and veal, wool, cotton, dairy, and wine. Based on forecasted values for 2012-2013 Australia's major agricultural export markets are as follows: China (14%); Japan (13%); ASEAN (20%); other Asia (15%); European Union (8%); Middle East 8%; United States 7%; other 15% (ABARES, 2012; ABARES, 2011).

Agriculture will be the next industry to benefit significantly from Asia-led growth. Australia and New Zealand stand to capture an additional A\$0.7-1.7 trillion and NZ\$0.5-1.3 trillion respectively in agricultural exports between now and 2050, however this growth will not happen of its own accord. Maximising growth will require Australia and New Zealand to overcome a broad range of barriers including capital constraints, skill shortages, land-use conflicts such as between mining and agriculture, and inefficient water markets, unfocused R&D and extension services, rising supply chain costs and market access limitations (Port Jackson Partners, 2012). The Australian Government released the National Food Plan on 25 May 2013, with sixteen goals to 2025, grouped broadly into growth of exports, developing a thriving industry, people factors such as education and skills and export of these skills and sustainable food.

2.2.3 *Tasmanian agriculture*

Tasmania occupies a land area of 68,300 square kilometres, of which nearly a third is committed to agriculture. Tasmania is a highly rural and regionalised state with approximately 60% of its population of 500,000 living outside its capital, Hobart (Department of Health and Human Services, 2008). Compared with other Australian states, it is characterised by a dispersed population and a proportionally great reliance on revenue from rural industries (Department of Primary Industries Parks Water and Environment, 2010). Agriculture has been Tasmania's most important industry since settlement. The main broad acre crops grown are oil poppies for pharmaceutical use, barley for malting and stockfeed and wheat for milling and stockfeed. The main livestock raised are cattle for beef and milk production and sheep for meat and fine wool. While apples are still Tasmania's main fruit crop, in recent years other crops such as cherries and strawberries have grown in significance. The main vegetable crops grown include potatoes, onions and carrots. These crops have benefited from the development of interstate and overseas markets, which have made them amongst the most valuable agricultural commodities produced in Tasmania (ABARES, 2014).

A Tasmanian Irrigation Scheme is being developed to grow the wealth of Tasmania by developing and enhancing the productive capacity of the State's agricultural industries. A total of \$200 million has been set aside by the Commonwealth and Tasmanian governments to progress the irrigation development, with the scheme being a public-private partnership (Tasmanian Irrigation Pty Ltd, 2014).

2.2.4 *Global dairy industry*

Dairy Farming is an agricultural activity that refers to the production of milk from farm animals. While dairy cows are traditionally associated with the industry, other species that may be milked commercially include sheep, goats, and buffalos.

A modest increase in consumption of dairy products is expected in developed countries with the exception of cheese and fresh dairy products, while in developing regions consumption of all products is expected to increase by 30% by 2021 (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012). Developing countries are projected to overtake developed countries in milk production by 2013, with large increases in China and India. The medium/longer term demand outlook for dairy consumption is particularly strong, driven by emerging market

demand, most notably in China. The per capita dairy consumption in developing nations such as China is increasing. Even a partial westernisation of diets in China would create enormous opportunities for the world's dairy producers. Growth in Chinese dairy consumption is already impacting global production and trade, particularly benefiting exporters in Oceania (Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organisation (FAO), 2012).

The world's most pronounced production increases have come from New Zealand, Australia and Argentina, assisted by favourable seasonal conditions. New Zealand is now the world's most important dairy product exporter, growing at 6% per year since 2005, with a large component of that growth attributed to China. This growth is anticipated to continue (Commonwealth Bank of Australia, 2010). New Zealand has capitalised on the growth of the Chinese market, whereas Australia has not had the same opportunity due to factors such as drought through the 2000s. Improved global production in the past decade can be explained by an improvement in individual cow production, as the global dairy herd has not increased in size (Commonwealth Bank of Australia, 2010).

2.2.5 The dairy industry in Australia

In this section, some background information on the Australian dairy industry will be presented, followed in the next section by detail on the Tasmanian dairy industry specifically.

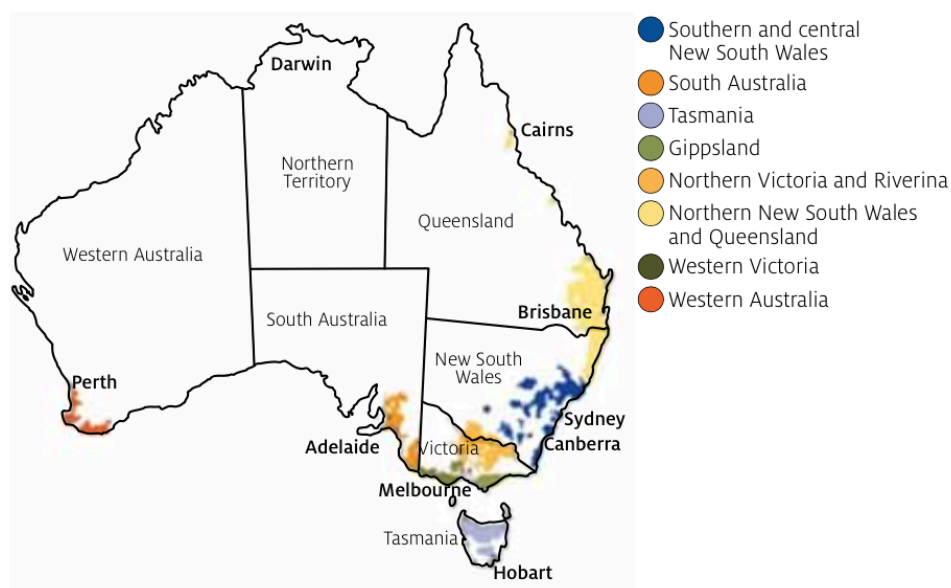


Figure 2-1 Dairy Farming regions.
Adapted from Dairy Australia (2013c)

The first seven cows and two bulls arrived in Australia in 1788 with Captain Arthur Phillip and the First Fleet, to provide milk and meat. By 1800, through breeding and importing, there were 332 bulls and 712 cows in Australia. Since the late nineteenth century, the Australian dairy industry has expanded through increased local demand and access to international markets for the sale of products manufactured using dairy ingredients. Today, the dairy industry is one of Australia's three most important rural industries, with a farm gate value of over \$3.9 billion in 2010/11, ranking third behind the beef and wheat industries (Dairy Australia, 2011a). Australia's eight dairy farming regions are described in Figure 2-1.

The dairy farm in Australia varies from a basic subsistence mode, to commercially smart, automated, integrated corporations. The traditional family dairy farm operated by a single person only, or with a partner decreased to 29% in 2012, compared to 43% in 2007 (Dairy Australia, 2012b). Most dairy farms now employ staff and the staff employed have a high turnover rate. Dairy Australia data from 2012 indicates that approximately 31% of workers had started their current roles in the past 12 months, while 15% were completely new to the industry (Dairy Australia, 2012b). The total number of people working on dairy farms is estimated to be 31,000, and the number in paid roles is over 13,000 in 2012 (Dairy Australia, 2012b). Further employment occurs through related transport and distribution activities, research and development projects, and manufacturing. The Australian Bureau of Agricultural and Resource Economics (ABARE) work estimates the regional economic multiplier effect to be in the order of 2.5 from the dairy industry (Dairy Australia, 2011a).

2011/2012	TAS	NSW	VIC	QLD	SA	WA	Australia
Number of registered dairy farms	444	778	4,556	555	275	162	6,770
Number of dairy cows (000 head)	145	205	1,075	95	95	54	1,670
Average annual milk production per cow (litres)	5,635	5,497	6,054	5,018	6,252	5,848	5,891
Average herd size	327	263	236	171	345	333	247
Milk production by state (million litres)	788	1,086	6,213	485	570	338	9,480
Percentage of national milk production	8	11	66	5	6	4	100
Typical factory paid prices by state \$/kg milk solids	5.19	6.60	5.46	7.33	5.76	5.97	5.69
Typical factory paid prices by state cents/litre	39.9	47.4	40.6	53.6	41.0	41.9	42.0

Table 2-1 Australian dairy industry farm statistics by state for the year 2011/2012.
Adapted from Dairy Australia (2013a).

The national dairy herd is comprised of 1.67 million cows, producing 9.480 million litres (2011/12). The average herd size is 247 cows, with an annual milk production per cow of

5,891 litres shown in Table 2-1 (Dairy Australia, 2013a). In 2012, 11% of herds in Australia had more than 500 cows and produced 33% of the total milk production in Australia (Dairy Australia, 2012a). On average, stocking rates on Australian dairy farms have increased over the past 20 years, often by increasing supplementary feeding.

Australia and New Zealand operate predominately a pasture based dairying system used more in New Zealand and Tasmania than the rest of Australia due to the high cost of alternative feed supplements in these places due to climatic conditions. 'Pasture based' refers to the fact that pasture, grazed by the cow in the paddock 23 hours per day is the primary feed source for the cow and hence the feed source that is converted into milk. Pasture is most plentiful in spring due to favourable seasonal growing conditions (more water and increasing soil temperature and day length); therefore milk from cows is cheapest to produce at this time of the year. For milk to be produced at other times of the year, supplementation to the grass is required in the form of grains, conserved fodder, or anything else the farmer can get cheaply that has the nutrients the cow needs to produce milk. The cost of feeding any of these supplements is normally greater than the cost of a cow eating grass.

Australian dairy farmers tend to calve their cows every year. The birth of calf, which is removed from its mother and reared separately, hence creates surplus milk from the cow, which is harvested by the dairy farmer through a milking shed. The majority of pasture based dairying systems are seasonal calvers, in that most of the cows are calved at the same time in spring to utilise the cheap seasonally produced pasture discussed above. It is this dairying system that produces large amounts of cheaply produced milk predominantly over spring. This surplus milk cannot all be consumed domestically and is utilised by the manufacturing industry to export internationally. To produce milk over the winter for domestic consumption is more expensive for all the reasons discussed above, therefore farmers are contracted to produce and paid extra for milk produced at this time of the year. Farmers will either calve a second herd in autumn to accommodate this production or alternatively will calve cows all through the year to maintain a constant level of production.

The majority of the states in Australia have a dairy industry (Figure 2-1). All of Australia's states have dairy industries that supply fresh drinking milk to cities and towns nearby. Seasonal milk production trends are shown in Figure 2-2

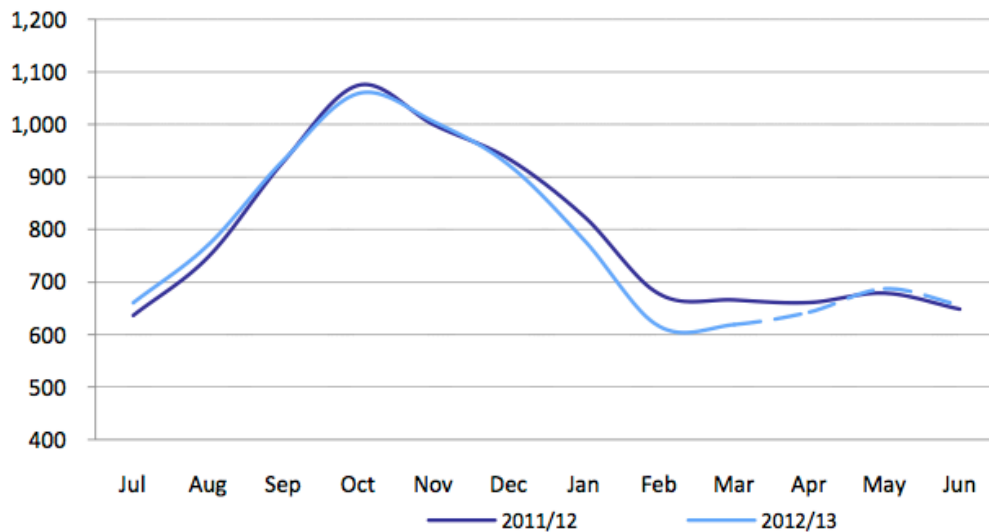


Figure 2-2 Monthly national milk production (million litres).
Adapted from Dairy Australia (2013b)

Predominantly occurring in the southern states, the surplus peak seasonal supply, 43% of the Australian milk produced (Dairy Australia, 2011a) is used in manufacturing and export. Globally, Australia's dairy exports total \$2.75 billion, which is 8% of the world dairy trade. Australia currently ranks fourth in terms of world dairy trade – behind New Zealand (34%), the European Union as a block (34%) and the United States (11%) (Dairy Australia, 2011a).

The Australian dairy industry showed strong growth through the 1990s but the growth has stalled in the last decade due to drought. However, as indicated above, over the past two decades, Australian milk production has been well above the volume required for domestic consumption, so that 40-60% has been destined for export markets. Additionally, the Australian dairy industry operates in a deregulated and open environment and has done so for over a decade. Therefore international markets and prices are the major factors determining the price received by farmers for their milk. Along with other industries, the Australian dairy industry has faced a long-term decline in the industry's terms of trade. The increased market and margin volatility in recent years has undermined farmers' confidence (Dairy Australia and ADIC, 2014 p. 9).

While there have been significant gains in farm productivity, the growth in Total Factor Productivity¹ for the dairy industry has been lower than for the wheat or beef industries.

¹ Total Factor Productivity (TFP) describes output beyond what was expected given the inputs and is used as a measure of technological change or dynamism. Its validity depends on all inputs being correctly accounted for HULTON, C. 2001. Total

For example Total Factor Productivity in dairy was on average 1.6% per year from 1980-2000 compared to 3.6% and 2.1% for the other industries respectively (Martin *et al.*, 2000). A key driver in improving farm performance is the provision and adoption of more efficient technologies and management practices (DAFF, 2005). Improved technologies and better management practices are important investments for dairy farmers to avoid declining real farm incomes. Most Australian dairy farms made at least one innovative change over the two years ending 2007-2008 (Liao and Martin, 2009). Overall, farmer confidence in the medium to long-term is fairly strong. In 2010-11, 63% of dairy farmers in Australia were positive about the future of the dairy industry (Dharma, 2012). The 2010/11 season saw improved milk prices, low grain prices, and favourable seasonal conditions which led to possibly the best production conditions for more than a decade (Dairy Australia, 2011).

Agricultural extension is used to assist farms in making performance and production improvements. The extension industry is a well-established sector consisting of government funded as well as independent consultants. Traditional extension consists primarily of farmer field days on a farm, the farmer being part of an extension group that meets on members' farms, or by physical participation in courses. The limitations with these modes of delivery include inflexibility in delivery time and content, the travel time to the delivery site, the wide range of farmer interests needing to be catered for and the ability to access specialists in a small rural community.

2.2.6 The dairy industry in Tasmania

The Tasmanian dairy farming region is further subdivided into three main Tasmanian dairying regions: the north east, central north and north west of the state, including King Island. Tasmania's 444 farms accounts for approximately 8% of national milk production, with average herd size being 327 cows, refer Table 2-1 (Dairy Australia, 2013a). The Tasmanian dairy industry is the most seasonal of all states; refer Appendix 3 for all states comparison, and Figure 2-3 with Tasmanian's seasonality, which may be compared with the Australian seasonality in Figure 2-2.

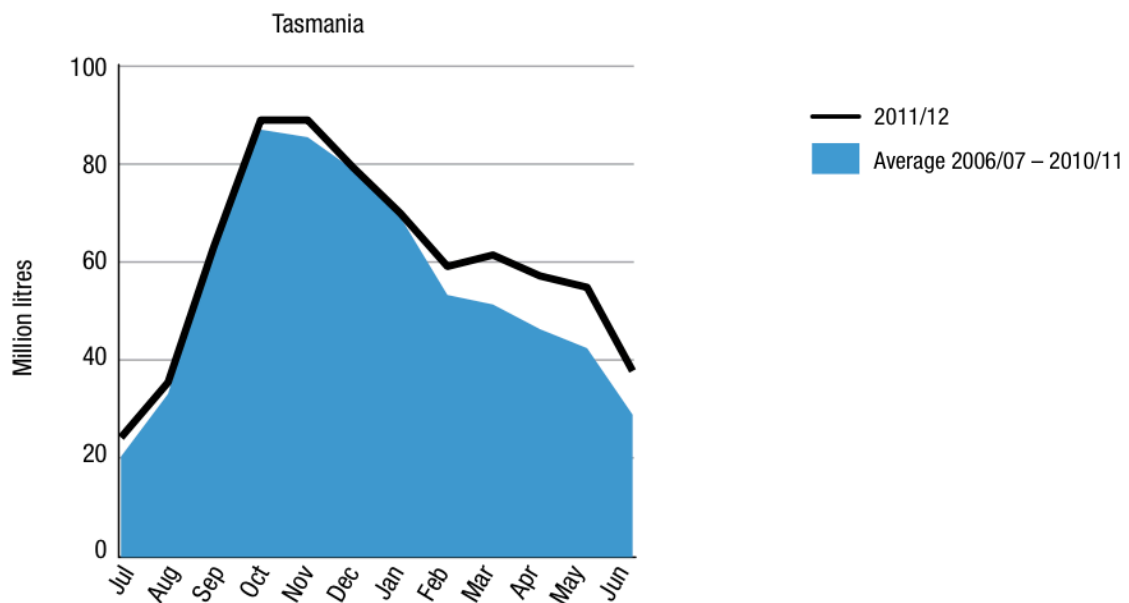


Figure 2-3 Seasonality of milk production in Tasmania 2011/2012 (million litres).
Adapted from Dairy Australia (2012a).

Tasmania milks the greatest peak number of cows per farm due to the seasonal nature of the farming system (Figure 2-4), although it does not have the highest average herd size (Table 2-1). The seasonality is due to milk production being largely based around the seasonal pasture growth curve, supplemented with irrigated pasture and crops, in comparison to Victoria that has access to cheap grain as well. This large seasonal peak and minimal requirements for drinking milk due to the small Tasmanian population means Tasmania has a large peak surplus production providing the opportunity for over 40% of Tasmania's milk production to be exported (Bills, 2013).

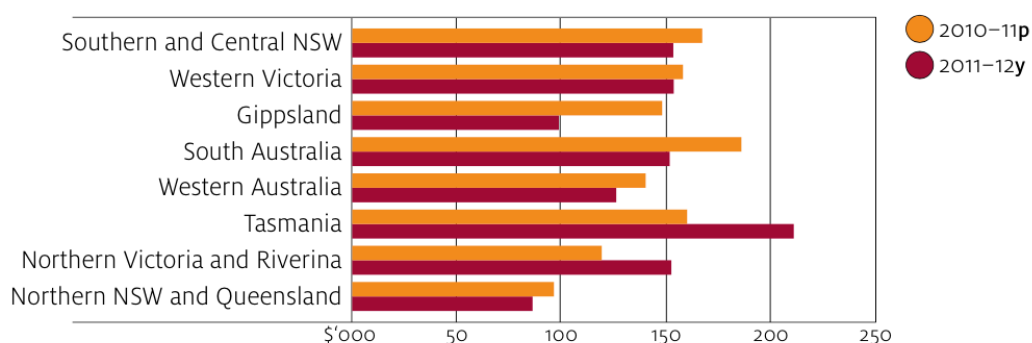


Figure 2-4 Maximum cows milked per herd for more than 3 months.
Average per farm. p ABARES preliminary estimate. ABARES provisional estimate. Adapted from Dharma (2012).

	Farm cash income		Farm business profit	
	2010–11p	2011–12y	2010–11p	2011–12y
	\$	\$	\$	\$
Northern NSW and Queensland	96 300 (13)	86 000	2 000 (844)	–22 000
Northern Victoria and Riverina	119 100 (32)	152 000	55 700 (57)	72 000
Tasmania	159 900 (18)	211 000	100 600 (27)	123 000
Western Australia	140 100 (21)	126 000	7 500 (384)	1 000
South Australia	185 800 (16)	152 000	93 100 (31)	21 000
Gippsland	148 000 (16)	99 000	81 100 (28)	16 000
Western Victoria	157 900 (19)	153 000	96 700 (31)	67 000
Southern and Central NSW	167 100 (16)	153 000	78 800 (35)	30 000

	Rate of return excluding capital appreciation		Rate of return including capital appreciation	
	2010–11p	2011–12y	2010–11p	2011–12y
	%	%	%	%
Northern NSW and Queensland	0.8 (58)	0.0	–2.2 (126)	na
Northern Victoria and Riverina	4.5 (24)	5.1	–0.6 (393)	na
Tasmania	5.5 (10)	5.8	5.0 (18)	na
Western Australia	1.0 (36)	0.9	–1.3 (101)	na
South Australia	4.6 (14)	2.7	3.3 (37)	na
Gippsland	4.5 (15)	2.3	3.9 (46)	na
Western Victoria	4.5 (15)	3.7	–1.7 (183)	na
Southern and Central NSW	3.5 (12)	2.7	3.4 (22)	na

Table 2-2 Financial estimates - Australian dairy farms, by region, average per farm.

Adapted from Dharma (2012). Note: Figures in parenthesis are standard errors expressed as a percentage of the estimate provided. Na Not available; p ABARES preliminary estimate. y ABARES provisional estimate.

Dharma (2012) forecasted the Tasmanian Farm Business Profit and Rate of Return in the years 2010-11 and 2011-12 to be above other dairying regions in Australia (see Table 2-2). This may explain why Tasmanian dairy farmers were the most positive (91%) of all states about the future of the national industry in 2012 (Dairy Australia, 2012b; Bills, 2013) (Figure 2-5). In the 2012 National Dairy Farmer Survey, a prominent area of concern for Tasmanian Dairy Farmers was labour with 25% of farmers interviewed considering it an issue, compared to only 10% of farmers in other states (National Dairy Farmer Survey 2012). Additionally, while over 30% of Tasmanian farmers were concerned over the milk price, this figure was lower than the rest of Australia at over 40%. The National Dairy Farmer Survey also highlighted a comparatively stronger intention to invest among Tasmanian dairy farmers. In Tasmania 51% were planning to increase production in the next year (Figure 2-6). This planned increase was more than any other states. Key planned investments assisting increases in production were irrigation (17%), dairy plant (11%) and shedding (11%).

Positive attitude to industry future by region (% farms)

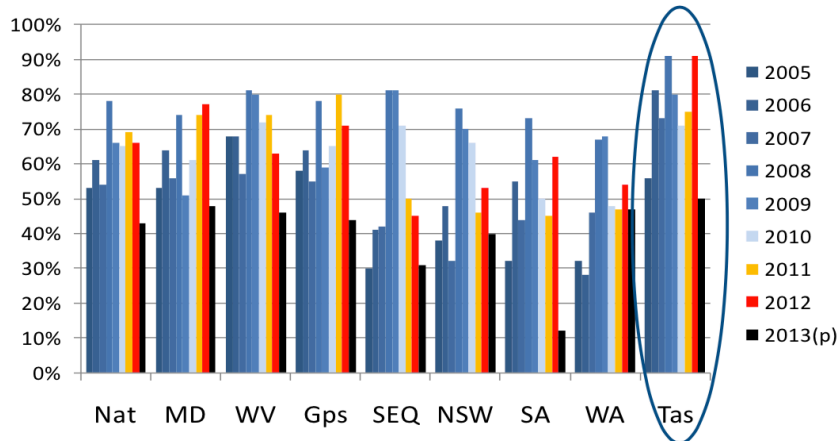


Figure 2-5 Positive attitudes to industry future by region (% farms).
Adapted from National Dairy Farmer Survey 2005-2013 Bills (2013).

Proportion of farms intending to increase production(%)

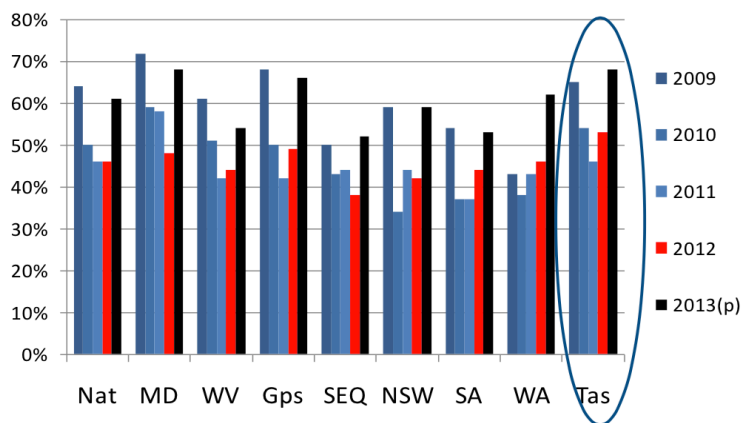


Figure 2-6 Three year growth outlook by region.
Proportion of farms intending to increase production (%). Adapted from Bills (2013).

2.2.7 Summary

Tasmanian family farm businesses are pasture based with minimal input systems that have a higher peak milk herd size than other states. Tasmanian farms are generally more profitable than other states and the farmers more positive about the industry. This research aimed to capture how these key farming characteristics interacted with the approach to and utilisation of ICT.

2.3 FAMILY FARMS AND SOCIOCULTURAL DIVERSITY

2.3.1 *The family farm business*

*Farm family businesses are distinctive; they behave in different ways from non-family businesses, because they are **family** businesses. By the same token farm families differ from other types of families, even families running other businesses, because they run **farm businesses**. (Errington and Gasson, 1993 p. 23)*

Family farming has been and remains to be the backbone of Australian agriculture (Vanclay and Fulton, 2011 p. 95). Ninety-eight per cent of Australian dairy farms are family owned, 2% are corporate owned and 90% are family-operated businesses (Dairy Australia, 2011b). A better understanding of human factors in the adoption of research in the agriculture and food industries is important to ensure intended research and development outcomes are achieved (DAFF, 2007). The farm family business is essentially a flexible organisation. The interweaving of family relationships with business objectives and activities gives it resilience, tenacity and durability that enables it to respond to internal and external pressures. Family farms behave in a business orientated way, however, their organisational processes are more complex with decisions being made within a multifaceted framework. This framework embraces the family's intrinsic values about farm work, the values of autonomy and family continuity as well as maximising profitability. Farmers place a high value on controlling their business. When 100 Cambridgeshire farmers were asked to rate 16 aspects of farming in order of importance (Gasson, 1973), the top six objectives were 1) doing the work you like; 2) independence; 3) making a reasonable living; 4) meeting a challenge, achieving an objective; 5) leading healthy, open-air life; 6) expanding the business.

Errington and Gasson (1993) considered there to be six elements of an ideal type farm family business:

- Business ownership is combined with managerial control in the hands of business principals;
- These principals are related by kinship or marriage;

- Family members (including these business principals) provide capital to the business;
- Family members including business principals do farm work;
- Business ownership and managerial control are transferred between the generations with the passage of time;
- The family lives on the farm.

The use of the family as a principal source of farm labour has previously been included in definitions of a family farm. Capital, mainly in the form of machinery, is helping to overcome the limitations that the reliance on family labour imposes on the family worked farm. When the major inputs for agricultural production were land and labour, the scale and nature of activities on the family farms were determined largely by the labour the family was able to supply. Production in traditional family farms was heavily dependent upon the number of children, stage in the family cycle, the age and health of the operator and spouse. Increased dependence on capital in the form of machinery means that business is no longer constrained by family labour supply (Gasson *et al.*, 1988 p. 19). This point was made 80 years ago.

So these are the two principal types of family-farmer – the thrifty, frugal peasant-cultivator of the old world, spending himself in a round of endless toil upon a small plot of land, and the pioneer of the new world working, probably, at equal pressure, but harnessing to his hand every mechanical device by which he can extend the scope of his operations. (Orwin, 1930 p. 84)

The need for continual direct monitoring in a farming environment, crucial where livestock is concerned makes it necessary for the farmer to live and work on the farm. The home and workplace are usually synonymous for the farmer and is a necessity for effective management.

Vanclay and Fulton (2011 p. 98) explored the strong relationship between the family and the land along with the farm's natural resources and biophysical constraints and defined family farming to be "the interaction between the family, the land which is farmed, and the farm business". Internal and external interactions were demonstrated to have an impact on the family farm business.

Family members also provide a substantial proportion of the regular labour input. This is not a necessary condition. The family farm today is more effective as a management unit

than as a labour unit (Hutson, 1987). Traditionally farming families were large and children were expected to work on the farm. More recently, farming families have decreased in size, while farms have increased and family labour has become less. There are complex reasons why family labour has decreased. Some women are seeking to improve their status through seeking professional employment off-farm or by taking a greater role in the management of the business (Vanclay and Fulton, 2011 p. 100). Symes (1972) described the stages of family development on the farm organisation as:

- **Inheritance and marriage** interchangeable in the time sequence;
- **Expansion** the period of family building between the birth of the first and the last children;
- **Stability** between the birth of the last child and the first migration of the offspring;
- **Dispersal** with a sub-stage to take account of the death of either spouse.

Two further stages were added to allow for various forms of family failure:

- **Residual household** caused by childless marriages or the failure to retain any offspring on the farm;
- **Relic households** arising from failure to marry.

Although usually regarded as a negative feature, cyclical variation of development and maintenance phases in the farm family business could actually aid survival. The cycle creates periodic pressure for innovation, which keeps the enterprise from stagnating and it creates periods of resistance to innovation when debts and risks are minimised (Errington and Gasson, 1993). There is no point at which even a majority of family farms will be over extended or vulnerable to a sudden downturn in profitability (Reinhardt and Barlett, 1989). Recent extreme climatic weather conditions may challenge this finding.

The prime objective for many family businesses is not profit maximization but succession, the desire to maintain control and to pass on a secure and sound business to the next generation (Errington and Gasson, 1993). This may be inter-generational, so short-term profitability may be sacrificed for longer-term growth. Farmers with children who are coming into the business or are encouraged into the business may be prepared to take on heavy financial commitments at a time when non-family farms might be consolidating rather than expanding. This may be to increase the size of the farm to allow other family members to live off the property income or to encourage other family members into the family farm business.

Business objectives are likely to change over the stages of the family cycle, reflecting the ageing of the farm operator, variations in labour supply and the importance of family needs at differing stages. The early phase of a family cycle typically consists of a young couple and no children past school leaving age, where family demands are high, but the young couple is energetic. This generally coincides with the establishment and growth phase of the farm. In the middle phase family members (children) may seek off-farm work, develop other enterprises within the framework of the farm business, or remain home possibly to avoid being unemployed. The late phase of the family cycle is where there are lower family needs, and less energy by the parents. Older farmers may be more concerned with minimising losses than with maximising profits, preferring to save rather than invest and expand (Gasson *et al.*, 1988 p. 96).

The process of succession, defined as the gradual transfer of control from one generation to another, has always been significant in family farming. The presence of a successor may have more influence upon business objectives and farm performance than the farmer's age (Errington and Gasson, 1993). A successor provides a constant incentive for forward planning and expansion reducing the likelihood of the business being rundown and capital consumed, if only to reduce workload.

2.3.2 Farm labour factors

Labour requirements on a dairy farm require work to be done at unsocial hours and this is the case for robotic milking systems at key times of the year such including calving. In a traditional non robotic farming enterprise, during the milking season cows are required to be milked early in the morning, 5:00 or 6:00 AM, and again ten hours later, seven days a week, normally with two labour units. During calving time, the farm is a 24-hour, seven-day-a-week job, with checking of the cows required during the night as well. The farm owner or manager generally does the calving and sorting out of the cows once they are calved as it is considered to be the most important activity of the year. Any cows that require assistance to calve must be recognised quickly and the correct calf needs to be linked to its mother. Cows may need assistance to calve, and it is vital that a newly born calf gets its parentage correctly identified. This can be a complex task if a large herd is calving in a tight calving pattern, meaning many calves are dropping, or being born at the same time on-the-ground at any one time.

Calving patterns of dairy farms are generally either all year round, or seasonal. All year milk production can either be achieved by a few cows calving each month, or by batch calving,

which is generally done in spring and autumn. Seasonal calving is done late winter and early spring so the cow is reaching peak milk production and is hence eating the most grass at the same time that the most pasture is naturally produced. This is the predominant calving pattern in Tasmania. This type of farming system has peak labour periods during calving and mating where skilled labour is required. During the rest of the year less skilled labour is required for the twice daily milking, and minimal labour is required during the period where the cows are not producing milk. Farm labour may be employed casually, part-time, full-time, or through contractors, particularly for silage/hay making.

The dairy industry has significant issues attracting a farm workforce due to its reputation for a lack of promotional opportunities and career development (Bitsch *et al.*, 2006), poor working conditions such as number of hours worked a week and lack of time off (Searle, 2001; Tipples *et al.*, 2004), a poor reputation in occupational health and safety (Bitsch and Olynk, 2008) and competition for the workforce from other industries (Nettle, 2012). These industries include office-based jobs and even sheep or beef farming due to the reduced requirement for stock work over the weekend.

Where historically family members have provided the majority of labour on family farms as farm sizes become larger there is an increased reliance on employed labour due to the decreased number of family members. There has been limited focus by farming systems researchers on the role of farm employment relations in the negotiation of sustainability and the future of farming. A renewed focus towards the human and social dimensions of work organisation in farming systems was suggested by Nettle (2012). With advancing technologies, there will also be the need for different skill sets to those traditionally needed and valued in the dairy industry (Dairy Australia, 2013b).

2.3.3 Sociocultural diversity in farming: farming styles and subcultures

Diversity in agriculture is one of the axiom of rural sociology – perhaps the most important one – but remains one which has not been fully considered (Vanclay *et al.*, 1998). The failure of the extension industry in Australia (Vanclay, 1994) is partly due to its failure to appreciate the differences between their various clients and the treatment of farmers as homogenous (Vanclay and Lawrence, 1995). Extension in particular has failed to appreciate the significance of the existence of sociocultural diversity in developing its extension programs and in the targeting of its messages. In understanding sociocultural diversity in

farming two key concepts have been explored extensively in the literature: 'farming styles' and 'farming subcultures'.

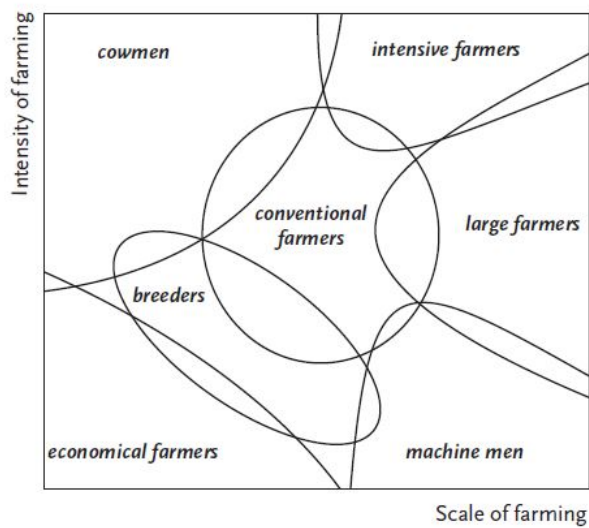


Figure 2-7 Farming styles in Friesian dairy farming.
(van der Ploeg 1994).

There is considerable literature on farming styles, in part because researchers with an interest in extension have sought to better understand the different ways that farmers combine their goals and strategies in order to improve their performance. 'Styles of farming' or 'farming styles' is a theoretical approach for understanding diversity in farming communities which was originally developed by Jan Douwe van der Ploeg, the Netherlands, in the late 1980s and early 1990s (van der Ploeg, 1994; van der Ploeg, 1995; van der Ploeg, 1985). Farming styles are essentially the different strategies applied by farm households in respect of the markets, policies and technologies relevant to them (van der Ploeg, 1994). The assumption is that different farmers define and operationalise their objectives and farm management practices on the basis of different criteria, interests, experiences and perspectives and in the process develop specific conceptualisations of how their farm should be organised, developed and managed.

A visual summary of farming styles identified by van der Ploeg (1994), cited in van der Ploeg (2000) pg. 498 is provided in Figure 2-7. These differing farming styles were used to assess the contribution of underlying strategies to the objectives of rural development. For instance, 'Farming Economically' was found to be one of the most important alternative and response to modernisation in the years 1960-1990. The styles of farming approach of Van der Ploeg has changed over the years. The essential idea is that within a farming community there is a set of discrete styles, or strategies of farming, which farmers are

acutely aware of and from which they actively choose a specific strategy to guide their own management. By participating in a style, they contribute to the evolution of that style over time. The styles are created not only through sociocultural dynamics but also as a response to structural forces and different styles potentially exist for different market situations of different farmers.

Author	Agricultural Sector	Styles Identified
Leeuwis (1993) cited in Vanclay <i>et al.</i> (1998)	Dairy	Multiple goaler; Thrifty farmer; Practical farmer; Cowmen; Machine men; Fanatical farmer
Roep and de Bruin (1994)	Dairy	Multiple goalers; Freewheelers; Cowmen; pioneers; Machine men; Optimal farmers.
van der Ploeg (1994) Considered by van der Ploeg to be similar to Roep and de Bruin (1994)	Dairy	Huge Farmers; Greedy Farmers; Cow breeders; Cowmen; Intensive farmers
Mesiti and Vanclay (1997)	Viticulture	Traditional growers; Innovative growers/progressive, Conventional; Labour efficient growers; Collins street growers/corporate growers; Lifestyles
Howden <i>et al.</i> (1998)	Broadacre	27 Styles – refer Table 2-4

Table 2-3 Farming Styles by researchers summarised

Major Styles	Minor styles	Poorly defined styles
<ul style="list-style-type: none"> • Innovative • Middle of the road • Progressive • Resource limited – personal • Resource limited – Structural • Traditional 	<ul style="list-style-type: none"> • Autocrat • Developer • Diesel • Burner • Doom and gloom • Expansionist • Grazing emphasis • Hard driver • Lazy • Lifestyler 	<ul style="list-style-type: none"> • Old rich • Opportunist • Organic • Perfectionist • Risk taker • Secret farmer • Skite • Tinkerer • Committee person • Lucky • Mediator • Safety-net farmer

Table 2-4 Twenty-seven farming styles.
(Howden *et al.*, 1998)

The principles of farming styles, which Vanclay (1994) in the Australian context terms as subcultures were introduced to Australia by Frank Vanclay in 1994 (Vanclay, 1994; Vanclay, 1995; Vanclay *et al.*, 1998). The general understanding of the farming subculture concept is that the primary motivation of farmers is their notion of 'good farm management'. Such a

social construct will vary between different groups of farmers and therefore wide ranges of meanings of good farm management exist. Early Vanclay papers did not define the notion of farming subcultures more fully and did not consider the idea that classifications of farmers into defined groups was possible or valuable. Further Australian research using this concept has been undertaken (Glyde and Vanclay, 1996; Howden and Vanclay, 2000; Howden *et al.*, 1998; Mesiti and Vanclay, 2006; Thomson, 2002) and in Europe (Noe and Alroe, 2003; van der Ploeg, 2000). Howden *et al.* (1998) (Table 2-4) identified 27 styles, leading them to question exactly what constitutes a style and how styles can be determined and identified. Unlike van der Ploeg, Howden *et al.* did not find that farmers were conscious of farming styles. The number of farming styles identified by Howden *et al.* and the researchers fundamental questioning of what constitutes a style makes linking farming styles to ICT adoption difficult.

Components of style	Description
1. As a repertoire of parables or stories about farmers that exists in the farming community	Repertoire of mythologised hypothetical constructions about farmers that are promulgated in farmers' and extension officers' talk.
2. As a set of strategies about how to deal with a specific situation	Set of practical guidelines and/or rationales for making decisions to deal with a particular situation (such as drought, flood, low prices).
3. As the set of the ideal types that farmers construct as the ideal form of their farm and which they seek to move towards	The farmers' goal
4. As the set of negotiated outcomes in farm decision making	Derived from the need of farmers' to compromise on the ideal farm or desired strategy they seek to implement because other people (such as a spouse, sibling, parent, child or off-farm financial shareholder) may have different notions from their own and because of the external and internal forces they must deal with
5. As on-ground manifested practice.	Styles exist as manifested in empirical farm practice which can be measured either by external assessment or by reference to farmers' own assessment of the different types of farm practice

Table 2-5 Reconceptualising farming styles
(Vanclay *et al.*, 2006)

Other research has identified various types of management strategies and management styles in farm businesses, as well as some of the factors that might influence farmers to adopt one style over another. Fairweather and Keating (1994) Identified three management strategies in the New Zealand farmer, the dedicated producer, the flexible strategist and the environmentalist and emphasised the importance of not overlooking the personal goals of the farmer. Brodt *et al.* (2006) found three similar styles: *Production Maximizers* emphasise working hard on the farm; *Networking Entrepreneurs* emphasise working smart so that they can save time for family and off-farm pursuits; and *Environmental Stewards* with their desire to be close to nature while still earning a livelihood. The prevalence of each of these styles of management may also be influenced by the context in which people are farming. For example, farmers who are cushioned from market forces by having sources of off-farm income may be freer to pursue non-economic goals such as those held by environmentalists (Flora, 1986). Management style may also be associated with phases of a farm business – it may be that farmers are more likely to be dedicated producers when they are young and trying to build the business, flexible strategists when they have developed the business, and environmentalists when the children are launched and expenses are reduced (Fairweather and Keating, 1994).

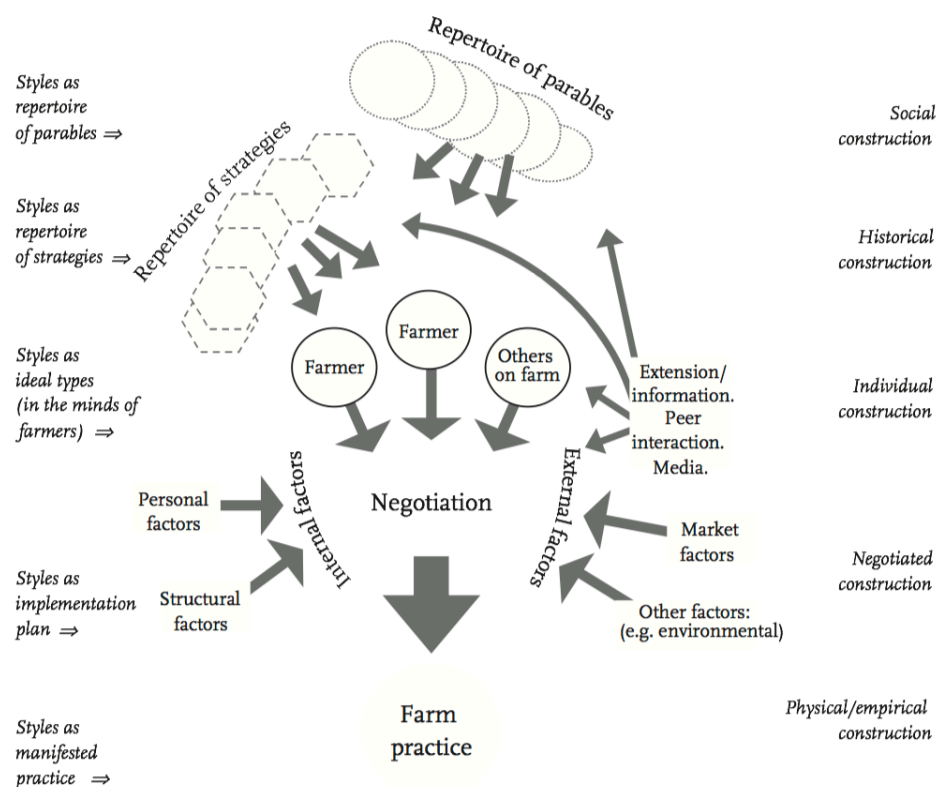


Figure 2-8 Operationalisation of style for an individual farm.
(Vanclay *et al.*, 2006)

A wide range of styles have been identified by different researchers, such as listed in Table 2-3. Vanclay *et al.* (2006) were unable to replicate or validate van der Ploeg's original conceptualisations and methodology and concluded that farming styles are more of an intellectual construction than a social construction. Their research experience led them to believe five different levels for farming styles can be construed, with the components or ingredients of a style varying depending on the level (Table 2-5).

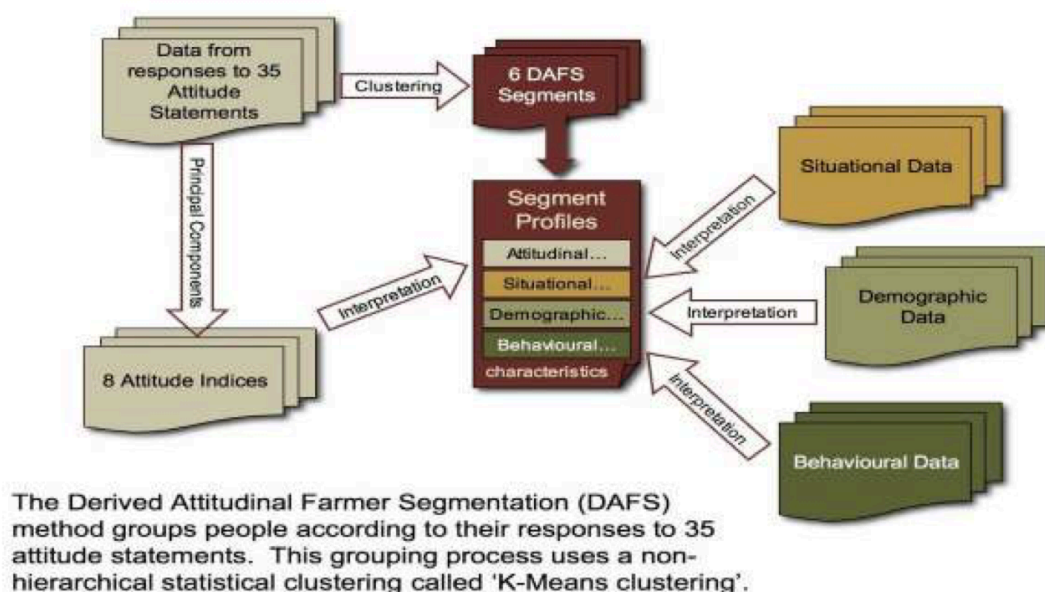


Figure 2-9 Schematic diagram explaining how DAFS are identified and interpreted. (Waters *et al.*, 2009)

DAFS group:	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Index	Family First 5.5%	Winding down 3.6%	Love farming 17%	Established and stable 24.9%	Open change 21.5%	to Growing for the kids 27.4%
Business Orientation	Low	Low	Average	Average	High	High
Aversion to Risk	High	High	Low	High	Low	Average
Sustainable Improvement	Low	Low	Average	Average	High	Average
Knowledge & Self-Reliance	Low	Low	Low	Average	High	High
Intergenerational orientation	High	Low	High	Low	Low	High
The 'Dairy Way of Life'	Average	Low	Average	Average	Average	High
Financial Pressure	High	Low	Low	High	Low	High
Farming Tradition	Low	Average	High	Average	Low	High

Table 2-6 Overview of attitudinal characteristics of each DAFS group.

Cells indicate if the group is higher, lower or close to the sample average of each attitudinal Index (Waters *et al.*, 2009). 'Low' = Lower than sample average. 'High' = Higher than sample average. Based on survey of 450 farmers milking more than 100 cows.

In the review of farming styles Vanclay *et al.* (2006) discussed and assessed eight issues about the concept of farming styles. Fairweather and Klonsky (2009) agreed with all but two of these assessments, that there is no method that can uncover styles of farming and the claim that such research is not useful for extension. From this Fairweather and Klonsky (2009) believed that a farmer centred approach (Q methodology) provided a useful and appropriate approach to develop farming styles. Further work was recommended on farming styles in order to clarify how and why application in different parts of the world has led to similar results, and to different results in others.

Emtage *et al.* (2006), conducted a comprehensive Australian focused review of literature on the identification of landholder typologies, with the aim to identify the possibility of a standardised, cross-regional and cross-industry landholder typology that would have application for the natural resource management sector. From this review, Waters *et al.* (2009) identified a method developed by Thomson (2001a); Thomson (2001b) which is now called Derived Attitudinal Farmer Segmentation (DAFS) (see Figure 2-9). This method was selected for its ability to explain or predict other behaviours such as participation in natural resource management initiatives, and to distinguish segments of farmers that have higher or lower propensities to adopt current recommended practices. This was in contrast to studies that aimed to characterise based on demographics and current farming practices. Thomson's method segments landholders on the basis of their perceptions of a wide range of situational and individual characteristics. Dairy Australia funded the obtaining of the data set of attitudes, demographics, behaviour change and information preference required to run the DAFS' process for the dairy industry, a focus on larger farms over 100 cows and from this Waters *et al.* (2009), concluded that Dairy Farm Businesses can be segmented into 6 broad groups based on farmer attitudes to dairying (refer Table 2-6 and Table 2-7). Thomson did not recommend naming these groups due to the likelihood that this would influence the interpretation of the characteristics of the styles because individuals have their own idea about what constitutes a label such as a progressive farmer. A name may also mean different things in different regions. However to allow dialogue with industry partners, Dairy Australia decided to name the categories (see Table 2-7). These groupings may be useful as predictors for dairy farmer use of ICT in the shed. Dairy farmers in group 2, winding down, would be less likely to use ICT, whereas uptake of ICT may be predicted by farmers in others such as groups 5 and 6 due to priorities focusing on the future.

	Description
Family First – 5.5%	Driven by the desire to maintain their farms to pass down generations. Established farmers that exhibit 'stable' growth. Not being constrained by financial pressures, may be willing adopters of change if can see benefit for the farm or family in long term. Likely to only consider changes that are well proven, and/or carry a low level of risk, and that will contribution to the ability of the next generation to continue in the farm business.
Winding Down – 3.6%	Don't tend to be under financial pressure, but don't make any changes to farming system to improve sustainability.
Love farming – 17%	Positive about future of dairying, motivated to encourage next generation. Willing to make improvements, open to taking risks, don't feel financial pressure the same as other groups. Higher than average levels of formal education, responsive to research and development outcomes, very open to new ideas and alternatives. Likely to run larger enterprises. Respond better to practical advice than that from academia.
Established and stable – 24.9%	Self-reliant, risk-averse, value dairy farming tradition, but not particularly concerned about future of farm in terms of intergeneration transfer. Fell under financial pressure. Relatively low average levels of formal education. More likely to run smaller enterprises. Lower than average adoption of practice change.
Open to change – 21.5%	Enjoy running a dairy business, motivated to develop a sustainable and successful business. Prepared to take calculated risks, Not particularly concerned about the tradition of farming, less likely to be motivated by ensuring the next generation continues on with farm. Willing listeners, early adopters. Younger than average, higher than average levels of formal education, average age of 49. More likely to run 'extra-large' and 'large' enterprises. Businesses expanding quickly. Highest level of practice change, and planning more. Very high rate of use of consultants and advisors. Consult a broad range of information sources. Highest rate of reported 'daily' use of the Internet. Information-hungry. Find it hard to get good labour, probably because use more of it, and require a higher level of skills and experience.
Growing for the kids – 27.4%	Enjoy running and developing a sustainable dairy business. Self-confident, risk aware and moderately constrained by financial pressures. Willing listeners to R&D outcomes, and motivated to adopt innovations that improve profits, improve lifestyle and/or ensure intergenerational success.

**Table 2-7 Description of 'styles'.
(Waters *et al.*, 2009)**

The usefulness of farming styles in extension is debated. While farming styles may be of interest, Vanclay *et al.* (2006) have argued that they are of limited use in targeting extension. Nevertheless, Fairweather and Keating (1994) suggest that technology transfer might be more successful if extension practitioners better understood how farmers with

the different styles would react to information or advice about new techniques or approaches to marketing. Certainly Waters *et al.* (2009) and Thomson (2001a); Thomson (2001b) have reported good prediction outcomes utilising their methods. The farming styles approach is more meaningful and useful than reductionist classifications based on structural, demographic or behavioural variables. Structural classifications tend to be simplistic as they make too many assumptions about the motives of farmers and are therefore limited in their capacity to predict behaviour and response to change (Thomson, 2001a).

2.3.4 Summary

Tasmanian dairy farms are predominantly family owned, passed down through generations. This study aimed to capture how family priorities, interactions and influences impacted on decisions made in the family farm business. The literature has identified that there is a need to better understand the human factors associated with adoption of research in agriculture, which may include attitudinal and other characteristics of farmers. Particularly when seeking to understand management decision making on family farms, family influences must be considered. The farming styles did not capture the family component of farming, which may be why even with 27 styles Howden *et al.* (1998) was not successful in predicting farmer behaviour. Waters *et al.* (2009), concluded that Australian Dairy Farm Businesses can be segmented into six broad groups based on the their attitudes to dairying. The use and adoption of ICT was not specifically considered in relation to these groupings. This research will apply the attitudinal characteristics of the groupings of Waters *et al.* (2009) to the question of ICT adoption.

2.4 INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) ON THE FARM

Information and communication technology (ICT) uptake in agriculture remains low and the reasons behind this have barely changed in the last 20 to 30 years (Csoto, 2011; Gelb and Voet, 2009). The main impediments to the use of ICT include the lack of tailored ICT applications, their increased sophistication which imposes human capital requirements, their lack of synchronisation with production, market and environment dictates and the essential ongoing end-user and extension training necessitated (Gelb and Voet, 2009).

New investments are an important means of boosting farm productivity and income, with productivity growth providing better prospects for farm business viability in the longer term (Mackinnon *et al.*, 2010). The largest category of new capital expenditure on dairy farms in 2008-2009 was tractors, followed by dairy sheds and equipment (Mackinnon *et al.*, 2010) which will include ICT. This research defines ICT on the farm as being predominantly those features that may be used as defined under Precision Dairy Farming. Precision Dairy Farming (PDF) is 'the use of information and communication technologies for improved control of fine-scale animal and physical resource variability to optimise economic, social, and environmental dairy farm performance' (Eastwood *et al.*, 2012). In Australia commercial application of precision dairying exists primarily as individual cow management undertaken using a computerised herd management system integrated with technologies such as electronic identification (EID), milk meters, activity sensors, automated drafting and teat spraying (Eastwood *et al.*, 2012).

2.4.1 ICT in Milking: Automation of traditional sheds and new Automatic Milking Systems (AMS), or robots.

No other new technology since the introduction of the milking machine has aroused so much interest and expectations among dairy farmers (de Koning, 2010a) as Automatic Milking Systems. Automatic Milking Systems, robots, or single boxes as they are referred to, is a mature technology in other areas of the world, with 80% of the world's automatic milking farms being located in north-western Europe. Since the first commercial systems appeared in 1992 in the Netherlands, AMS have been installed at an increasing rate. In Europe 40% of all new shed investments being made are AMS and up to 80% in Denmark, with over 20,000 AMS in place globally in 2200 farms in over 20 countries (de Koning, 2010a). Of the estimated 8,000 farmers (2009) worldwide that have adopted AMS, (Svennersten-Sjaunja and Pettersson, 2008) the majority are located in northern Europe (90%), Canada (9%), and USA (1%).

AMS remove the onerous labour requirements from milking thus dramatically altering the nature of dairy farming, with dairy farmers having indicated that the number one reason for investing in an AMS being the potential savings in labour, although this is not always actually the case (Jacobs and Siegford, 2012). AMS can be more than just a substitute of robots for labour. Automatic sensors, particularly those that monitor udder health, milk

production, reproductive status, feed intake and body weight changes provide detailed information about each cow, which was not easily obtained with previous management and milking systems (Spahr and Maltz, 1997). The defining feature of an automatic milking system (AMS) is that a human is not required to put the cups on the cow – rather a robot does. Removing the human from this task provides the opportunity for ICT to be utilised to provide information about the cow to the human when they are elsewhere on the farm. The technology becomes the farmers' information source to identify the problems. AMS (Robotic milking) changes the way the farm is run. Suddenly the farmer is not required to be putting cups on cows early in the morning and again last thing at night, meaning farming becomes closer to being an '8-5' job, although still 7 days a week. This appeals to the next generation taking over the farm, as well as the current generation. Time is also saved with the majority of the cows voluntarily bringing themselves up to be milked, rather than the farmer having to physically get the cows and bring them to the shed.

AMS is not only a new way of physically milking the cows, but also a completely new management system. The main difference between AMS and conventional systems is the reliance on the cows to go voluntarily and individually to be milked (Spörrndly and Wredle, 2005). Understanding the motivations and mechanisms that effectively induce cows with access to pasture to return to AMS is important and more research on the combination of AMS with grazing systems is needed if the combination is to be more widely considered by farmers (Jacobs and Siegford, 2012). Reasons for slow adoption of AMS in the United States may include producer uncertainty about adopting the new technology, the lack of readily available service providers to assist with mechanical problems, the USA's larger herd structure than Europe and access to cheaper labour (Jacobs and Siegford, 2012).

The use of AMS in Australia has been low to date (de Koning, 2010b; Svennersten-Sjaunja and Pettersson, 2008). Reasons for the limited uptake in Australia include larger farm sizes and the focus on pasture-based grazing systems which add complexity to management with AMS (Eastwood and Kenny, 2012). Interest is growing in successfully combining AMS with pasture-based systems in Europe, Australia and New Zealand although few researchers have explored this area (Jacobs and Siegford, 2012). In Australia the first commercial AMS has been operating since 2001, but it was not until 2009 that this number jumped to nine, and in 2012 there are 18 commercial AMS installations in Australia. A similar pattern has occurred in Tasmania, with two commercial installations operating in 2011, and five in 2012, including the world's first commercial robotic rotary (AMR™). Globally it is predicted

that by 2016, 22% of all dairy farms and 18% of all dairy cows will be milked under AMS (Ron Mulder 2012, Tasmanian Dairy Conference). In Australia, it is predicted there will be 41-89 AMS installations in 5 years. This is 5-10% of the new dairy infrastructure (Kenny and Eastwood, 2011).

Key drivers for investing in AMS revolve around labour and lifestyle and are not necessarily financial, with some farmers suggesting that the cost of a new fully automated Rotary or Herringbone dairy is comparable to the installation of an AMS. Specific reasons for adoption additionally include attracting the younger generation into farming through farm succession, the appeal of technology, not having to milk cows, the ability to attract and retain better quality labour, fewer physical demands, which is beneficial for older farmers or those with health issues (Kerrisk and Ravenhill, 2011; Kerrisk and Ravenhill, 2010; de Koning, 2010a).

Apart from AMS, the other use of ICT for milking cows is to retrofit or install a traditional rotary or herringbone milking shed. The most common type of milking shed used on Australian dairy farms is a herringbone shed (Figure 2-10), with 75% of dairies being of this type. These may either be a swing-over, where the cups get swung from one side to the other, or a double-up, where there is a set of cups for each side of the shed. Rotary sheds (Figure 2-11) are favoured by farmers with large dairy herds, with 15% of Australian dairies currently of this type. The typical rotary farm milks an average peak of 389 cows, which is double the average for farms with a swing-over herringbone shed. Tasmanian dairy farms have specifically 52% swing-over herringbones, 31% Double herringbones and 25% Rotaries (Dharma *et al.*, 2012), with some farms having more than one dairy type on a property.

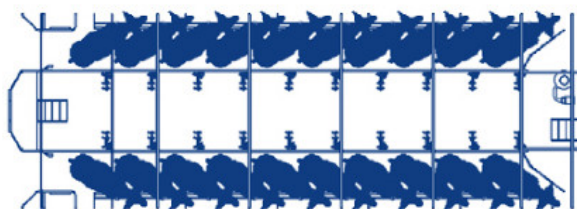


Figure 2-10 Example of a Herringbone shed.
Adapted from DeLaval (2014b)

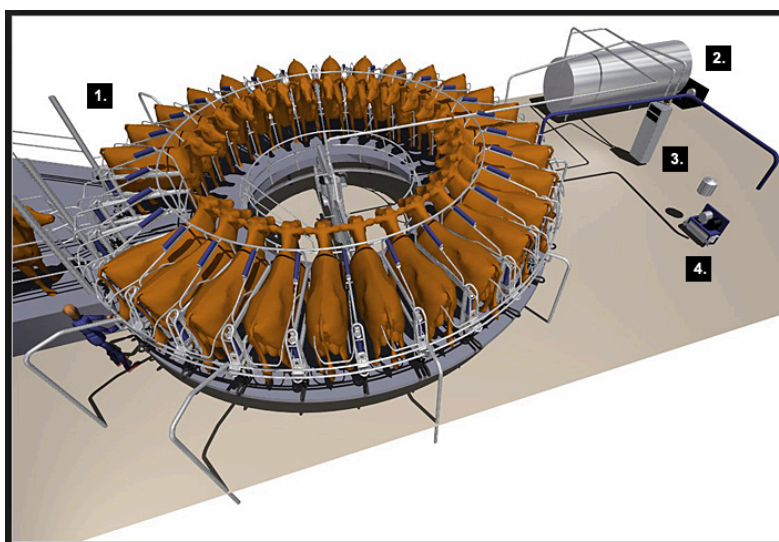


Figure 2-11 Rotary Dairy.
Adapted from DeLaval (2014a)

Automation of dairy shed operations is highest in farms with rotary sheds (Mackinnon *et al.*, 2010). This shed type has the highest proportion of automatic backing gates, vat cleaning systems, cup removers, teat spraying and milk flow meters. Common automation in sheds includes milk meters, drafting gates, teat sprayers, cup removers, vat cleaning, backing gates, and individual cow bail feeding (Figure 2-12). Some of these additions are primarily labour or time saving devices, such as teat spray, backing gates and vat cleaning, however, ICT automation options are defined under the title ‘precision dairy farming’ and utilise electronic ear tags to individually recognise the cows to enable recording of individualised milk production data and to assist in herd management events such as heat detection, health testing for mastitis, detection of lameness and individual cow bail feeding (Eastwood, 2008; Dharma *et al.*, 2012).

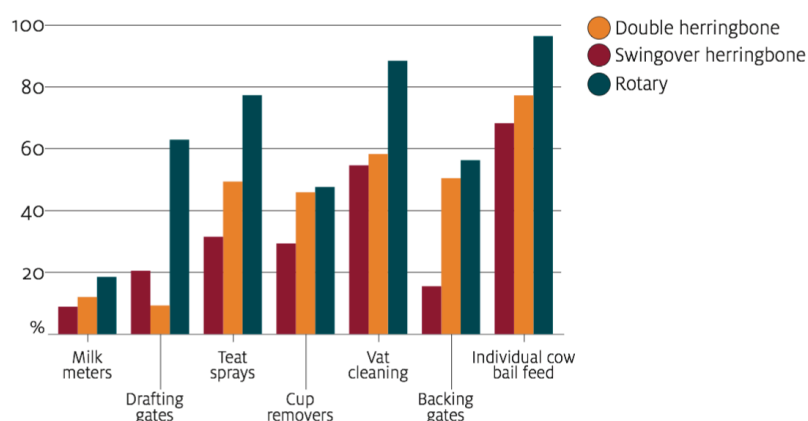


Figure 2-12 Automation by shed type,
2010-11 proportion of farms (Dharma *et al.*, 2012)

2.4.2 ICT for farm and herd management

This section defines in more detail some components of ICT on the farm.

The National Livestock Identification System (NLIS) is Australia's system for identifying and tracking dairy and beef cattle. NLIS provides opportunities for dairy producers to improve their management and profitability through the use of the Electronic Identification (EID) in conjunction with a range of technological applications on farm. Using currently available equipment and herd management software, many aspects of dairy herd management can be simplified and given great accuracy, resulting in greater efficiency and bigger profits.

NLIS allows individual animals to be identified and tracked anywhere on the farm for farm management, as well between properties and from property of birth to slaughter for bio-security, meat safety and market access. Livestock traceability improves overall product integrity by assisting in disease management and continuous animal monitoring through feed and weight sensing. The system relies on radiofrequency identification (RFID) tags that are attached to the animal's ear, inserted under the skin or worn around the neck. The NLIS tag contains a microchip that can be read electronically, meaning transcription errors can be eliminated saving both time and labour in the dairy shed. Electronic ID can be linked to many everyday activities such as herd management events, electronic milk meters, computer controlled feeding, treatment records and automatic sorting and weighing.

Herd management systems are predominantly used to manage all aspects of individual cow health and production. Milk production data can be entered either from herd-testing data, or if present on-farm milk meters if this form of ICT is installed. Mating data entered assists with prediction of calving patterns, when to dry cows off and when cows are due to calf. Health data such as lameness and mastitis treatments assist in the decision to cull or treat with long-acting antibiotics, dry-cow, when milking is stopped for the year, drying off the cows. The first use of computers as a management tool in dairy farming was by the milk recording services starting in the 1950s in the United States (Voelker, 1981). Computerised information systems can potentially help the dairy producer to deal with the increased complexity of decision making and availability of information in dairy farming (Pietersma *et al.*, 1998). Fully automated dairies have a herd management system that is integrated into the automation components of the dairy. Computerised information systems should be fully integrated to ensure a coordinated execution of dairy farming activities (Pietersma *et al.*, 1998), however this is not necessarily the case, with farmers concerned over software compatibility (Kutter *et al.*, 2011).

The slow adoption of Precision Agriculture (PA) has been attributed to the lack of functioning Decision Making Tools (McBratney *et al.*, 2005). Decision Support Systems (DSS) have seen poor uptake despite improved usage benefits. Failures have been attributed to interface difficulties perceived to be complex and time consuming to use and inappropriate information for the end user (Car *et al.*, 2012). Decision support systems need to be redesigned toward providing agricultural users with a more efficient time management and study environment and facilitating group interaction (Maruster *et al.*, 2009). In many cases our ability to collect data has exceeded our ability to understand and apply this data in a meaningful way (Lamb *et al.*, 2008).

Remote sensing is applied to objects that cannot be physically measured. There are two remote sensing techniques, active and passive. Active sensing techniques employ energy emissions systems such as radar, sonar and X-ray to scan and detect objects. Passive sensing detects naturally reflected radiation from objects or areas of interest. In the field of geodesy, the geologic science of the size and shape of the earth, remote sensing deals with the collection of satellite data from various sources including GPS and forms of radiating or, reflecting emissions such as magnetic fields, infrared, visible light and ultraviolet radiation (National Oceanic and Atmospheric Administration, 2014). The data collected and analysed provides useful information for a growing range of services.

Remote sensor networks are used by Australian organisations such as CSIRO, Bureau of Meteorology, Geoscience Australia and Landgate to: 1) observe events; 2) collect data to provide for services including weather forecasting, monitoring climate change, monitoring forests, conducting surveillance and border security, fire monitoring, farm monitoring, space activity monitoring, and 3) undertaking magnetic field surveys to assist industries such as mining (ACMA, 2011c). 'Pastures from Space' is a CSIRO, Department of Agriculture – WA and Landgate collaborative project that provides estimates of pasture production during the growing season by means of remote sensing. Satellite data is used to accurately and quantitatively estimate Pasture Biomass or Feed On Offer or combined with climate and soil data is used to product Pasture Growth Rates. Estimation of Pasture Growth Rates and Feed On Offer provides temporal and spatial information on feed resources allowing producers to more effectively manage their enterprise. Free downloads of the data are available, however, commercial third-party software is required farmer-useful application of the data for the application of farm feed budgeting, on an individual paddock level for a

farmers' unique farm. This software 'Pasture Watch' has been developed by Fairport Technologies.

2.4.3 ICT for communication and information

The digital economy is important to most Australians with almost three-quarters of the adult population believing the Internet has improved their day-to-day lives. The real benefits of the Internet are demonstrated by the increasing frequency of Internet use and the range and scope of activities performed online (ACMA, 2012 p. 1).

While consumers' patterns of internet use have shifted in some areas, the internet usage patterns of Australian small businesses have remained largely unchanged over the last two years (ACMA, 2012 p. 16). Australian organisations play a critical role in facilitating participation in the digital economy through developing online service channels (ACMA, 2012 p. 7). One of the ways this was achieved was by small businesses increasing their online presence with a 15% increase in .au domain name registrations between June 2011 and June 2012 (ACMA, 2012 p. 2). Businesses need to address the issues of doing business in a world that is rapidly becoming more electronically enabled and dependent (Bryceson, 2003). The Internet and associated electronically enabled business practices are business supporting technologies that are well established, forming an electronic landscape within which business is carried out.

Australia makes up a relatively small portion of the smartphone and tablet market, and does not have a significant impact on global trends (ACMA, 2013b p. 8). Global trends have a strong bearing on developments and trends in Australia, with pre-purchase reviews easily accessible online. Smartphones continue to develop interactive capabilities using a range of sensors embedded and integrated into the device. Proximity sensors, GPS, accelerometers, gyroscopes, digital compasses, light sensors, temperature sensors, improved touch sensors and auto sensors are part of the technological mix that developers are using to create innovative smartphone applications capable of turning objects, locations and people into networked interactive elements (ACMA, 2011c p. 21).

Through 3G or 4G mobile phone networks, Internet services are able to be accessed either via a mobile wireless broadband service using a dongle, data card or USB modem connected to a computer or via Internet enabled mobile phone handset. 3G networks are reported to cover in excess of 99% of the Australian population at June 2010 (ACMA, 2010). The actual coverage based on landmass for voice and data in Tasmania is shown in Figure

2-13. The carrier Telstra is selected because all of the research participants had mobile services provided by Telstra. As can be seen below in Figure 2-13, Telstra's reported coverage leaves many areas of no reception for dairy farmers in Tasmania.

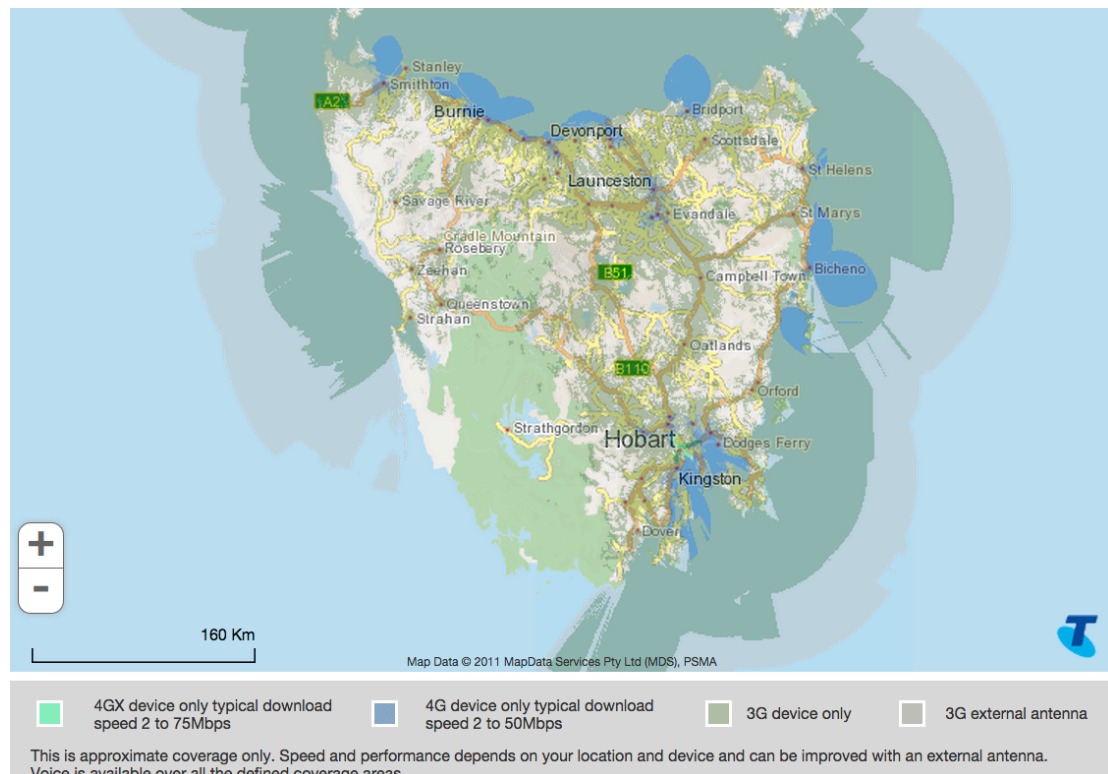


Figure 2-13 Telstra mobile network coverage – data.
(Telstra, 2014)

Australians are increasingly identifying the mobile phone as their most used communication device. Mobile networks are being upgraded to support 4G services, and this combined with the expansion of Wi-Fi networks have been key facilitators for the development of the smartphone/tablet. As at 30 June 2013 there were 19.6 million subscribers with Internet access connections via a mobile handset in Australia, an increase of 13% from 17.4 million subscribers at the end of December 2012. The volume of data downloaded via mobile handsets for the three months ended 30 June 2013 was 19,636 Terabytes, a 43% increase from the three months ended 31 December 2012 (ABS, 2013).

The take-up of smartphones increased from 25% of the adult population at June 2011 to 49% at May 2012. There were an estimated 8.67 million smartphones and 4.37 million tablet users in Australia at May 2012, with 3.65 million using both a mobile phone and a tablet to access the Internet (ACMA, 2013b). The increase in smartphone usage has given

rise to significant growth in mobile phone Internet access and data usage compared to other phone users, with smartphone users:

- Nine times more likely to go online via their handsets;
- Four times more likely to purchase goods online;
- Three times more likely to stream or download audio or video content;
- Three times more likely to play bills online;
- Two times as likely to access social networking sites.

(ACMA, 2013b p. 1)

Mobile only users use only a mobile phone and choose not to have a landline. Sixty-three per cent of mobile only users live in a metropolitan area. Close to 3.3 million Australians aged 18 and over, 19 per cent of the population were mobile-only users at the end of 2012, replacing their fixed-line home phone with a mobile. The number of mobile only users grew by 20% in the 12 months to December 2012, consistent with growth rates in the previous two years, with the largest increase being in the 25-34 age group (Figure 2-14). The number of fixed-line home Internet connections being replaced by mobile connections is also growing (ACMA, 2013c). Factors contributing to this shift include consumers improved access to new, improved and affordable technology, 4G mobile network upgraded services, more flexible mobile plans and converging technologies and devices allowing users to access multiple communication and media services from a single device.

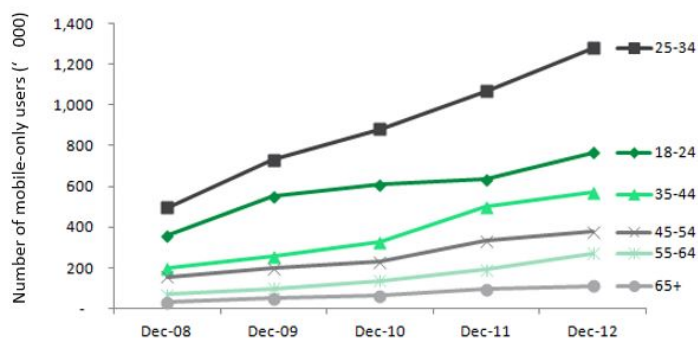


Figure 2-14 Growth of mobile-only users by age group in Australia.
(ACMA, 2013c)

Internet activities conducted by mobile phone by mobile-only users are shown in Table 2-8, with 63% of mobile-only users living in metropolitan areas.

Type of Internet activity	Users '000	Growth	Most popular activity
Information	1,353	82%	Maps or directions
Email and messaging	1,283	60%	Email
Entertainment	1,116	64%	Streamed video
Surfing and browsing	1,088	90%	General browsing
Banking and finance	999	94%	Checking bank account balances
Online communities	819	51%	Social networking
Transactional activities	545	79%	Research a product or service to buy

Table 2-8 Growth in the 12-month period to December 2012 (ACMA, 2013c)

Mobile technology is useful for improving information access and provision for primary producers in rural areas (Lu and Swatman, 2008). The use of mobile technology has both social and commercial drivers (Lu and Swatman, 2008).

2.4.3.1 Internet access and communication

There were 12,358,000 Internet subscribers in Australia at the end of June 2013. This represents an increase of 2% since the end of December 2012 and an annual growth of 3% (ABS, 2013). The number and proportion of Internet connections that were dial-up continued to decline, with over 98% of Internet connections being broadband. In the six months to 30 June 2013 there was an increase of 3% to 6.2 million mobile wireless broadband connections in Australia. Mobile wireless broadband is the most prevalent Internet technology in Australia, accounting for half of all connections. In percentage terms, fibre was the fastest growing type of Internet access connection, increasing by 26% since the end of December 2012, to 115,000 connections at 30 June 2013 (Table 2-9).

	Jun 2012 '000	Dec 2012 '000	Jun 2013 '000
Dial-up connections	439	282	227
Broadband connections			
DSL	4 632	4 727	4 787
Cable	917	918	934
Fibre	52	91	115
Satellite	94	92	93
Fixed wireless	30	49	49
Mobile wireless	5 862	5 995	6 150
Other	10	7	3
All broadband connections	11 597	11 879	12 131
Total number of subscribers	12 036	12 161	12 358

Table 2-9 Internet subscribers by type of access connection. For ISPs with more than 1000 subscribers (ABS, 2013)

The National Broadband Network (NBN) is currently is being rolled out, which is reflected in the increased figure uptake illustrated in Table 2-9. Satellite broadband is an Internet service connected via satellite. It is available across Australia's entire land area but due to

its higher cost to consumers and problems with latency and speed it is mainly used in areas with poor or no coverage from other service delivery platforms, such as rural Tasmania, (ACMA, 2011b p. 13). On the 1 July 2011, the NBN interim satellite service to rural and remote areas became available, with the first priority given to those eligible customers who currently have no alternative access to commercial broadband services. The service is expected to offer peak speeds of 6 Mbps downlink and 1 Mbps uplink using existing satellite capacity purchased from other operators. NBNCo (2014) report that the capacity of this service has already been reached. The delivery of NBN Co's long-term satellite service is expected in 2015 with the launch of two next-generation Ka-band satellites, delivering wholesale Internet speeds up to 12 Mbps downloads and 1 Mbps for uploads. This service will provide access to the NBN outside the fibre and fixed wireless footprints. The service is expected to provide broadband coverage to around 3% of homes and businesses in Australia including outback areas and Australia's external territories such as Norfolk Island, Christmas Island, Macquarie Island and the Cocos Islands (NBNCo, 2014).

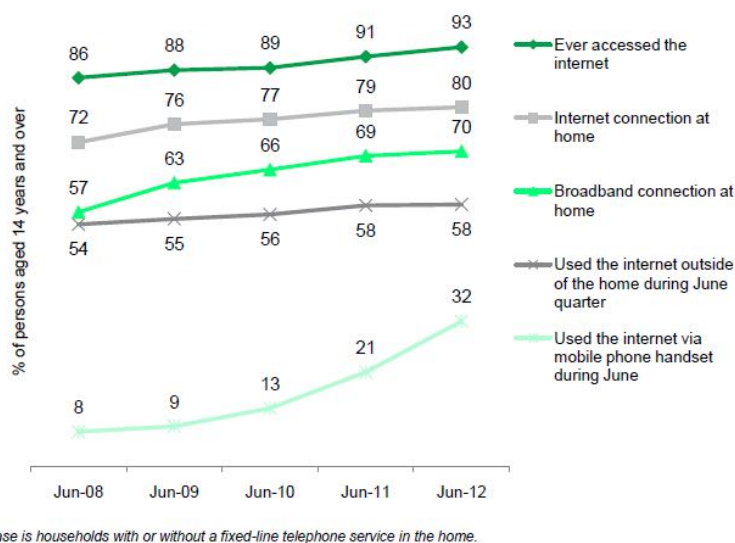
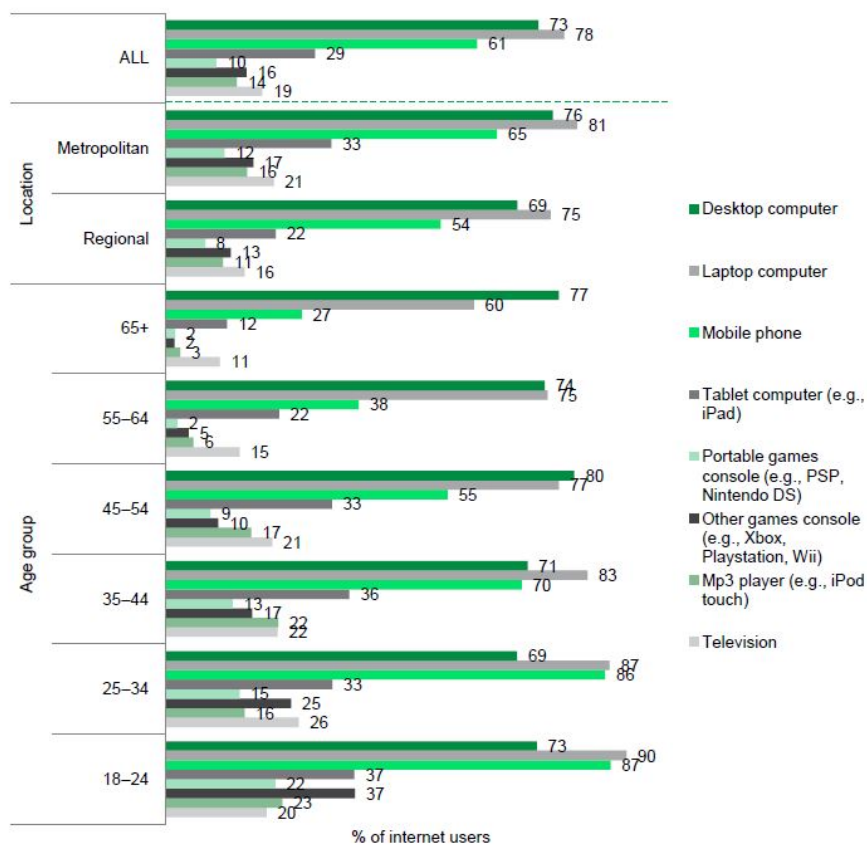


Figure 2-15 Access to the Internet.
(ACMA, 2012).

Most Australians have access to the Internet. They have some form of broadband service in their home and go online from a range of locations, home, work and in other locations (Figure 2-15). At June 2012, 73% of Internet users went online more than once a day, with activities relating to shopping and entertainment. (ACMA, 2012). Internet access is important to recent innovation in consumer communications and media devices with Australian households going online via a range of consumer devices (Figure 2-16).

Wireless cellular networks will play a significant role in sensing and monitoring for both human interfacing devices such as smartphones and machine-to-machine devices, as they provide not only connectivity but also mobility. Embedded mobile sensors and their associated services depend on wireless networks to offload their data to back-end servers in the cloud. This referred 'cloud' in computing terminology is the use and access of files, services and applications through a computer network such as the internet (ACMA, 2011a p. 23). The cloud provides unprecedented scalability and resources for the collection and analysis of large-scale sensor data. Cloud services are likely to play a large role in sensing and monitoring as they provide computing capabilities and storage capacities not yet available on the sensor devices themselves (ACMA, 2011c p. 24).



Note: Relates to Australian telecommunications users with home internet access. Time series not available.

Figure 2-16 Devices used to access the Internet.
In the six months to May 2012, by age and location (ACMA, 2012)

Computerised information systems can potentially help the dairy producer to deal with the increased complexity of decision-making and availability of information in dairy farming. These systems should be fully integrated to ensure a coordinated execution of dairy farming activities (Pietersma *et al.*, 1998).

Social media is critical in regional Australia for innovation (Higgins, 2011). Regional Australia has the ability to greatly increase its levels of innovation in the areas of community, business and technology by using social media to interact and share ideas with individuals and businesses domestically and internationally that would otherwise not be possible. This access to ideas and information can be used to implement innovative changes on the farm. The ability to do so will improve as Internet connections improve but without this opportunity, there will be a widening gap between the innovative capacities of major cities and regional areas because of the difference in the range of interactions that can occur (Higgins, 2011). Some researchers have found that farmers' participation in social and commercial networks is an important driver of innovation in rural areas (May, 2011).

The Internet has provided the way for farmers to access information using websites and more recently YouTube for both personal and business purposes. Social media is also beginning to gain recognition as a tool for use in the Australian Rural industries. Higgins (2011) describes social media as not being time bound. This enables individuals to contribute ideas around a topic and potentially enable action. Social media allows chance encounters with information and people with whom contact may not otherwise occur. Rapid expansion of broadband capabilities into rural and regional Australia for national coverage is important for information exchange in agricultural and natural resource management extension (Hunt *et al.*, 2012).

The Australian Communications and Media Authority (ACMA) commissioned qualitative research engaging stakeholders and the community, and some of the findings are presented in this section. Australian individual barriers preventing engaging in online activity are presented in Table 2-10, with the greatest mitigating factors for use of the Internet and the degree to which the below are or are not barriers being age and experience.

Dharma *et al.* (2012) collected sources of information specifically for farmers, however, ICT methods were not included. They focussed on breaking down personal information sources such as private consultants, family, milk company staff. An insight is still provided into areas of influence, specifically that within Tasmania 66% of farmers consider other farmers or families to be a source of information for farm management advice, and that 23% use media sources. Similarly, information on participation and involvement in physical activities such as field days, and farmer discussion groups was also collected, and seemingly not measured for online methods.

Barrier	Description	
Lack of knowledge or ability	That certain services exist and 'how to' engage with those services	More prevalent among older audiences and for more recent and emerging technologies and services
Lack of confidence	Uncertainty in being able to negotiate services or use emerging and new technologies safely, securely and 'correctly'	More common among older audiences
Privacy concerns	Safety of the information provide, trustworthiness of services provided/offered Concern over digital footprint and ownership of generated content	More informed younger users, among older audiences
Lack of perceived need or interest	Not feeling any need or having any interest in engaging with particular services Feeling more able to access services offline	'Time rich' people
Fear that 'offline' values do not always apply in the online world	Certain behaviour is seen to be wrong, for example bullying/harassment Fear that 'wrong' behaviour sometimes dominates online behaviour of others.	

Table 2-10 Barriers to engagement of Internet services.
(ACMA, 2013a)

2.4.4 Summary

Individual Tasmanian dairy farms utilise a diverse cross-section of ICT, ranging from robotic milkers, large computerised dairies, through to small enterprises with no computer herd management systems, or ICT in the dairy. This study aimed to capture perspectives encompassing this diverse cross-section of farming systems. The literature identified rural communities as having reduced connectivity in the form of mobile and Internet access, with social and business implications. This study focused on capturing how current connectivity influenced family farm business and family life on a day-to-day level, as well as projecting forward perceived requirements and limitations in the future. Business and personal factors were considered, with family farm businesses by definition requiring an integration of both. This research will extend the work of Dharma *et al.* (2012) by studying ICT as a source of information for farmers.

2.5 ADOPTION AND USE OF ICT

The focus of the research reported in this thesis is the adoption and use of ICT in the dairy industry in Tasmania. And overview of the agricultural industry both globally and locally has been provided in section 2.1 to place the research in context. A background to the

family farm business and sociocultural diversity has been introduced in section 2.2, with the literature identifying that there is a need to better understand the human and family factors associated with adoption of changes to the farming system. There is emerging literature suggesting that the behaviour of Australian dairy family farm businesses can be predicted by grouping the family farm businesses on their attitudinal characteristics (Waters *et al.*, 2009), although ICT use and adoption was not specifically considered.

This section of the literature review will firstly examine the extensive Information Systems (IS) literature on ICT adoption. The key adoption models in the IS discipline have been developed and studied in traditional business organisations using employees as the focus of the studies. Such studies may or may not align with ICT adoption in the dairy industry where the person adopting is a farmer or business owner rather than the employee of a large organisation. This will be followed by a review of literature pertaining to ICT adoption in the agricultural setting by family farms. Criticisms of past ICT studies will then be discussed.

2.5.1 Information Systems literature on adoption of ICT

Sections 2.5.1.1 (Theory of Reasoned Action); 2.5.1.2 (Theory of Planned Behaviour); 2.5.1.3 (TAM, TAM2, TAM3) and 2.5.1.4 (Unified Theory of Acceptance and Use of Technology) below examine the literature in the Information Systems discipline pertaining to ICT adoption in general.

2.5.1.1 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action is “one of the most fundamental and influential theories of human behaviour” (Venkatesh *et al.*, 2003). The model (Figure 2-17) is a social psychological model, which assumes that individuals are usually rational and will consider the implications of their actions before deciding whether or not to perform a given behaviour (Fishbein and Ajzen, 1975). The constructs of TRA are fundamentally motivational in nature with the theory stating the immediate antecedent of any behaviour is the *intention* to perform the behaviour in question. The stronger a person’s intention, the more the person tries, and hence the greater the probability that the behaviour will be achieved. The theory specifies two independent determinants of behaviour. The first, a personal factor *attitude towards the behaviour*, refers to the degree to which a person has a favourable or unfavourable evaluation of the behaviour in question. The second predictor of intention is *subjective norm*, a social factor that refers to the perceived social pressure to perform or not to perform the behaviour. These two factors attitude and

subjective norm, each weighted for relative importance are assumed to jointly determine Behavioural Intention.

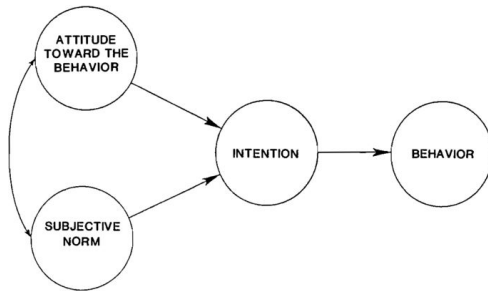


Figure 2-17 Theory of Reasoned Action.
(Fishbein and Ajzen, 1975)

The greatest limitation of the theory is the requirement that behaviour under consideration be under volitional control (Ajzen and Madden, 1986). Any limitation such as time, money, skillset, or required co-operation of other people takes the behaviour out of voluntary control.

2.5.1.2 Theory of Planned Behaviour (TPB)

This theory extends the theory of reasoned action by including the concept of *Perceived Behavioural Control*, theorised to be an additional determinant of intention and behaviour. Perceived Behaviour Control is 'the perceived ease or difficulty of performing the behaviour' (Ajzen, 1991 p. 188). Information Systems research explores, 'perceptions of internal and external constraints on behaviour' (Taylor and Todd, 1995 p. 149). This is the person's belief as to how easy or difficult performance of the behaviour is likely to be. Perceived Behaviour Control encapsulates beliefs about whether one possess the necessary skills, resources and opportunities to execute the behaviour and the power of these factors to actually facilitate or inhibit the behaviour. Relations between behaviour and intention and between intention and attitude in Perceived Behavioural Control are assumed to be linear. In effect, TPB is an additive model with respect to the primary determinants of behaviour and intentions. The Technology Acceptance Model TAM, as discussed in section 2.5.1.3 consistently outperforms this model in terms of explained variance across many studies (Davis *et al.*, 1989; Venkatesh *et al.*, 2003). Therefore this model was not considered the best model to use in this study.

Criticisms include the fact that TPB ignores important interactions between the proximal determinants of behavioural intentions (Eagly and Chaiken, 1993; Umeh and Patel, 2004). One particular concern of motivation models such as TPB is that intention is deployed as

the dependent variable, implicitly assuming near-perfect correspondence between intention and behaviour. As might be expected, a much larger proportion of the variance in intention is explained than that in behaviour. In their comprehensive review of the literature on attitudes, Eagly and Chaiken (1993) identify several aspects of the TPB that necessitate further scrutiny. In particular, they note that the model fails to account for potential interactions between its central components. While, as the TPB suggests, attitude, subjective norms and PBC impinge independently on intention. Eagly and Chaiken argue that several moderator effects are possible. For example, people who assume they have control over a behaviour would not necessarily act if the behaviour were negatively evaluated e.g., insulting total strangers or driving recklessly. Controllability may facilitate a behaviour only to the degree that one has a positive attitude towards the behaviour. Alternatively, Perceived Behavioural Control may inhibit a behaviour if it is appraised negatively. This interaction can also be viewed from the perspective of attitude. Positive evaluations may instigate or have no effect on a behaviour given the strong and weak perceptions of control, respectively. It is possible that social pressure to enact a behaviour would have little impact if that behaviour is viewed negatively e.g. health conscious young people who refuse to smoke despite tremendous peer pressure, but increase intentions if the behaviour is positively evaluated. Similarly, a positive attitude may facilitate a behaviour only to the extent that significant others approve but have little or no impact if there is a hostile social context.

Conner and Armitage (1998) present both narrative and meta-analytic evidence to support extension of the TPB. Two variables in particular are shown to contribute independently to the prediction of intention, over and above TPB variables, self-identity and moral norms. Self-identity refers to the salient part of an actor's self which relates behaviour to societal goals; moral norms are concerned with personal feelings of obligation to perform or not to perform a particular behaviour. Further work extending the TPB may therefore be required.

Reflecting on technology policy implications: as Ajzen (1991 p. 206) has noted, intention, attitude, subjective norms and perceived behavioural control each reveal "a different aspect of the behaviour, and each can serve as a point of attack in attempts to change it". The relative importance of attitudes, subjective norms, and perceptions of behavioural control for the prediction of intentions is expected to vary from behaviour to behaviour and population to population (Ajzen, 1988; Ajzen, 1991; Fishbein, 2000). The results of these

models can guide strategies for changing technology behaviour, as discussed by Madden *et al.* (1992).

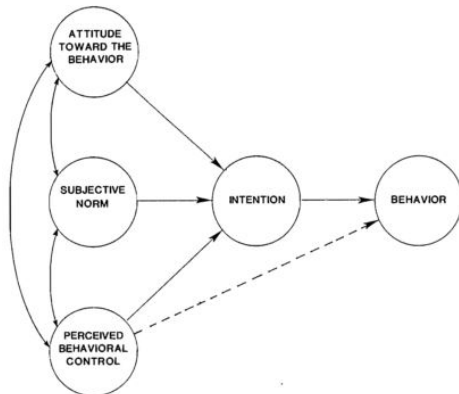


Figure 2-18 Theory of Planned Behaviour.
(Ajzen and Madden, 1986)

2.5.1.3 Technology Acceptance Model (TAM), and evolutions TAM2, TAM3

The Technology Acceptance Model (TAM) (Davis *et al.*, 1989) “is tailored to IS contexts, and was designed to predict information technology acceptance and usage of the job” (Venkatesh *et al.*, 2003 p. 428). Of all the theories TAM is considered the most influential and commonly employed theory for describing an individual’s acceptance of information systems (Lee *et al.*, 2003). TAM has consistently outperformed TRA and TPB in terms of explained variance across many studies (Davis *et al.*, 1989; Venkatesh *et al.*, 2003), with TAM being an adaptation of TRA. The theory pays special attention to the influence of external factors on the beliefs, attitudes and intentions to use. The TAM model was used to theorise that an individual’s Behavioural Intention to use a system is determined by two beliefs, Perceived Usefulness, defined as “the extent to which a person believes that using the system will enhance his or her job performance”, and Perceived Ease of Use, defined as “the extent to which a person believes that using the system will be free of effort” (Davis, 1989 p. 320). The TAM model was used to theorise that the effects of external variables e.g. system characteristics, development process, training on intention to use are mediated by Perceived Usefulness and Perceived Ease of Use (Venkatesh and Davis, 2000 p. 187). A diagram of TAM is shown in Figure 2-19.

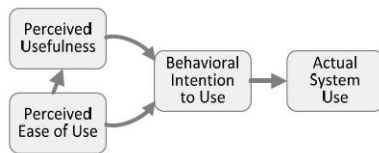


Figure 2-19 TAM.
(Davis *et al.*, 1989)

Researchers such as Dwivedi *et al.* (2008) identify that historically predominantly similar methods of Information Systems (IS) or Information Technology (IT) adoption and diffusion research have been preferred, primarily using empirical and quantitative techniques and survey methods and that TAM has been used and have raised concern that this may lead to a failure to gather insights that can emerge from alternative theoretical perspectives. A shortcoming in TAM is that it provides only limited guidance about how to influence usage through design and implementation with Perceived Ease of Use and Perceived Usefulness being treated as ‘black boxes’ (Venkatesh *et al.*, 2003; Benbasat and Barki, 2007). Researchers have been criticised for broadening rather than deepening TAM through explaining Perceived Usefulness and Perceived Ease of Use, reconceptualising existing variables in the model or introducing new variables to explain how the existing variables produce the effects that they do (Bagozzi, 2007).

Technology Acceptance Model 2 (TAM2)

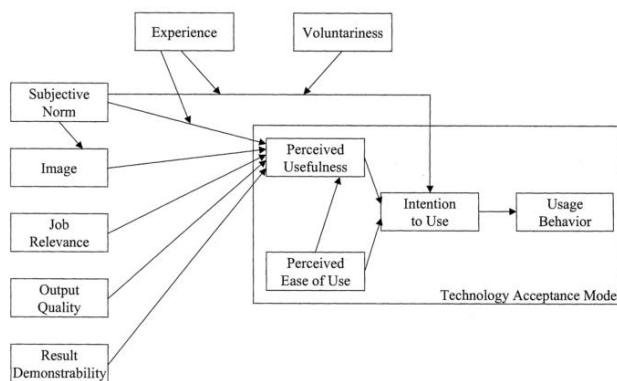


Figure 2-20 TAM2
(Venkatesh and Davis, 2000)

Venkatesh and Davis (2000), identify that TAM had some limitations in explaining the reasons for which a person would perceive a given system useful and so they proposed that additional variables could be added as antecedents to the Perceived Usefulness variable in TAM, and called it TAM2. TAM2 (Figure 2-20) expands TAM by explaining Perceived

Usefulness and Behavioural Intention to use in relation to the process of social influence and cognitive instruments. An explanation of the determinants for Perceived Usefulness is described in Table 2-11.

Determinants	Definitions
Perceived Usefulness	The extent to which a person believes that using the system will enhance his or her job performance (Davis <i>et al.</i> , 1989)
Subjective Norm	The degree to which an individual perceives that most people who are important to him think he should or should not use the system (Fishbein and Ajzen, 1975; Venkatesh and Davis, 2000)
Image	The degree to which an individual perceives that use of an innovation will enhance his or her status in his or her social system” (Moore and Benbasat, 1991)
Job Relevance	The degree to which an individual perceives that use of an innovation will enhance his or her status in his or her social system” (Moore and Benbasat, 1991)
Output Quality	The degree to which an individual believes that the system performs his or her job tasks well” (Venkatesh and Davis, 2000)
Result Demonstrability	The degree to which an individual believes that the results of using a system are tangible, observable, and communicable” (Moore and Benbasat, 1991)

Table 2-11 Perceived Usefulness determinants for TAM2

TAM3

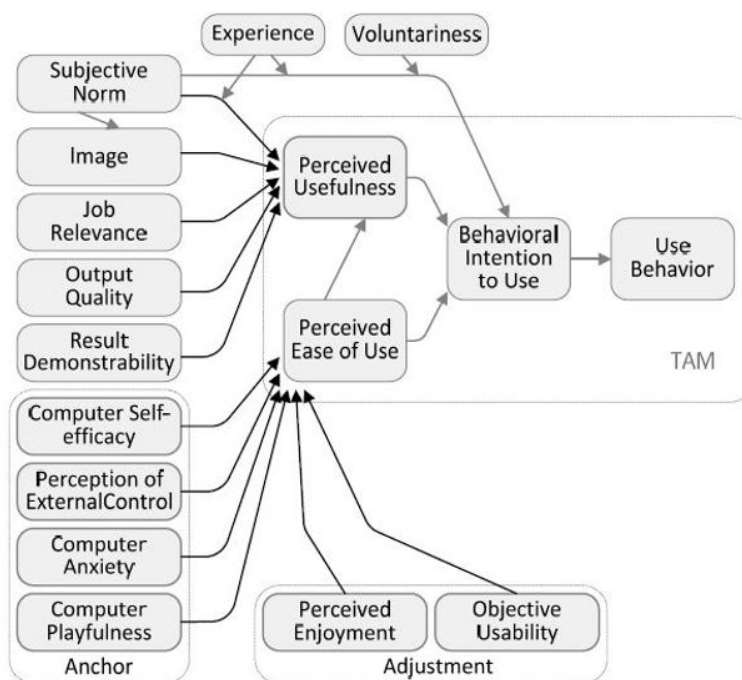


Figure 2-21 TAM3
(Venkatesh and Bala, 2008)

Separately from the development of TAM2, Viswanath (2000) identified general determinants of Perceived Ease of Use, summarised in Table 2-12. Venkatesh and Bala (2008), by combining TAM2 (Venkatesh and Davis, 2000) and the model of the determinants of Perceived Ease of Use (Viswanath, 2000) developed an integrated model of technology acceptance – TAM3 which is presented in Figure 2-21. TAM3 presents a complete nomological network of the determinants of individuals' ICT adoption and use, with the strength being in the comprehensiveness and potential for actionable guidance. TAM3 suggests there are no crossover effects between Perceived Ease of Use and Perceived Usefulness with the determinants of each not influencing the other. TAM3 proposes that with increasing experience, while the effect of Perceived Ease of Use on Behavioural Intention will diminish, the effect of Perceived Ease of Use on Perceived Usefulness will increase. This implies for long-term use of ICT, that system ease of use is a factor. Venkatesh and Bala (2008) argued that effective interventions such as training are essential to ICT adoption and use.

Determinants	Definitions
Perceived Ease of Use	The extent to which a person believes that using the system will be free of effort (Davis <i>et al.</i> , 1989)
Computer self-efficacy	The degree to which an individual believes that he or she has the ability to perform a specific task/job using the computer (Compeau and Higgins, 1995a; Compeau and Higgins, 1995b)
Perception of external control	The degree to which an individual believes that he or she has the ability to perform a specific task/job using the computer (Compeau and Higgins, 1995a; Compeau and Higgins, 1995b)
Computer anxiety	An individual's apprehension, or even fear, when she/he is faced with the possibility of using computers (Viswanath, 2000 p. 349)
Computer playfulness	An individual's apprehension, or even fear, when she/he is faced with the possibility of using computers (Viswanath, 2000 p. 349)
Perceived enjoyment (Adjustment)	The activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use (Viswanath, 2000 p. 351)
Perceived enjoyment (Adjustment)	Comparison of systems based on the actual level (rather than perceptions) of effort required to completing specific tasks" (Viswanath, 2000 pp. 350-351)

Table 2-12 Perceived Ease of Use determinants

2.5.1.4 Unified Theory of Acceptance and Use of Technology (UTAUT) and UTAUT2

UTAUT

The Unified Theory of Acceptance and Use of Technology – UTAUT, (Figure 2-22) (Venkatesh *et al.*, 2003) was proposed as a means to integrate fragmented theory and

research into a unified theoretical model. Eight models were reviewed, the Theory of Reasoned Action, the Technology Acceptance Model, the motivational model, the Theory of Planned Behaviour, a model combining the Technology Acceptance Model and the Theory of Planned Behaviour, the model of PC utilisation, the innovation diffusion theory (see section 2.5.2.1), and the social cognitive theory. A model with four core determinants of intention and usage and up to four moderators of key relationships was formulated by Venkatesh *et al.* (2003). *Performance expectancy*, *Effort expectancy*, *social influence* and *facilitating conditions* were considered to have a significant direct determinant role in user acceptance and usage behaviour (Venkatesh *et al.*, 2003 p. 446-455). These are defined in Table 2-13. *Attitude towards using technology*, *self-efficacy*, and *anxiety* were theorised not to be direct determinants of intention. UTAUT has been primarily useful in organisational settings, explaining about 70% of the variance in behavioural intention to use technology and about 50% of the variance in technology use (Venkatesh *et al.*, 2012).

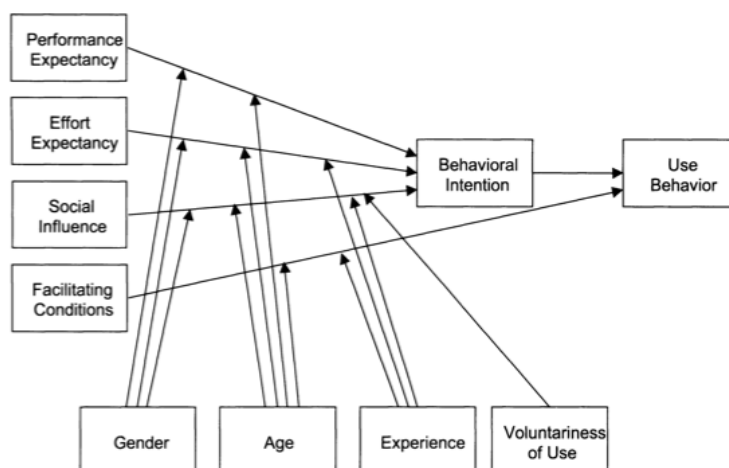


Figure 2-22 Unified Theory of Acceptance and Use of Technology UTAUT
(Venkatesh *et al.*, 2003)

UTAUT has been criticised as bringing us back a full circle to TAM's origins through adding social influences and facilitating conditions to the two main constructs of TAM, Perceived Usefulness and Perceived Ease of Use and hence creating a model not very different from the Theory of Planned Behaviour (Benbasat and Barki, 2007). There is also criticism that moderators are demographic variables, providing little theoretical insight to explain the reasons behind proposed interaction effects, with this model having at least 41 independent variables (Bagozzi, 2007).

Determinants	Definitions
Performance Expectancy	The degree to which an individual believes that using the system will help attain gains in job performance. Influence on behavioural intention moderated by gender and age, stronger for men and particularly young men.
Effort Expectancy	The degree of ease associated with the use of the system. Influence on behavioural intention moderated by gender, age and experience. The effect is stronger for women, particularly younger women, and particularly at early stages of experience.
Social influence	The degree to which an individual perceives that important others believe the new system should be used. Influence on behavioural intention moderated by gender, age, voluntariness and experience. The effect is stronger for women, particularly older women, particularly in mandatory settings in the early stages of experience.
Facilitating conditions	The degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system. No significant influence on behavioural intention. Influence on usage of technology moderated by age and experience, stronger for older workers, particularly with increasing experience.

Table 2-13 UTAUT determinants and moderators
(Venkatesh *et al.*, 2003)

UTAUT2

Determinants	Definitions
Performance Expectancy	The degree to which using a technology will provide benefits to consumers in performing certain activities. Moderated by age and gender.
Effort Expectancy	The degree of ease associated with consumers' use of technology. Moderated by age, gender and experience.
Social influence	The extent to which consumers perceive that important others (e.g. family and friends) believe they should use a particular technology. Moderated by age, gender, and experience.
Facilitating conditions	The consumers' perceptions of the resources and support available to perform a behaviour. Effect on use behaviour is moderated by age and experience. Influence on behavioural intention is moderated by age, gender and experience, with the effect being stronger among older women in early stages of experience with a technology.
Hedonic motivation	The fun or pleasure derived from using a technology. Influence of behavioural intent is moderated by age, gender and experience, such that the effect is stronger among younger men in early stages of experience with a technology.
Price Value	Consumers' cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them. Influence of behavioural intent is moderated by age and gender, such that the effect will be stronger among women, particularly older women.
Habit	A perpetual construct that reflects the results of prior experiences. Influence on behavioural intention and also technology use is moderated by age, gender and experience, such that the effect will be stronger for older men with high levels of experience within the technology.
Experience	Experience will moderate the effect of behavioural intention on use, such that the effect will be stronger for consumers with less experience.

Table 2-14 UTAUT2 determinants and moderators.
(Venkatesh *et al.*, 2012)

When reviewing the use of UTAUT, Venkatesh *et al.* (2012) observed that most studies using UTAUT employ only a subset of the constructs, particularly by dropping the moderators and thus concludes there was a need to tailor the model to a consumer use context. The UTAUT2 model extends UTAUT to study acceptance and use of technology from an organisational to a consumer context. In an organisational context, performance expectancy is the main driver of technology use intentions and behaviours. In the case of consumers' acceptance and use of technology, other drivers such as the pleasure of using a technology, hedonic motivation and price value come into play (Venkatesh *et al.*, 2012 p. 172). With this in mind, three additional key constructs were identified, relationships in the original conceptualisation of UTAUT were altered, and new relationships introduced.

The three additional constructs are incorporated into UTAUT2 are *hedonic motivation*, *price value*, and *habit*, with Individual differences – specifically *age*, *gender*, and *experience* moderating the effects of these constructs on *behavioural intention* and *technology use*. The model is shown in Figure 2-23, and the determinants described in Table 2-14, with the determinants and moderators being adapted to the consumer technology acceptance and use context (Venkatesh *et al.*, 2012).

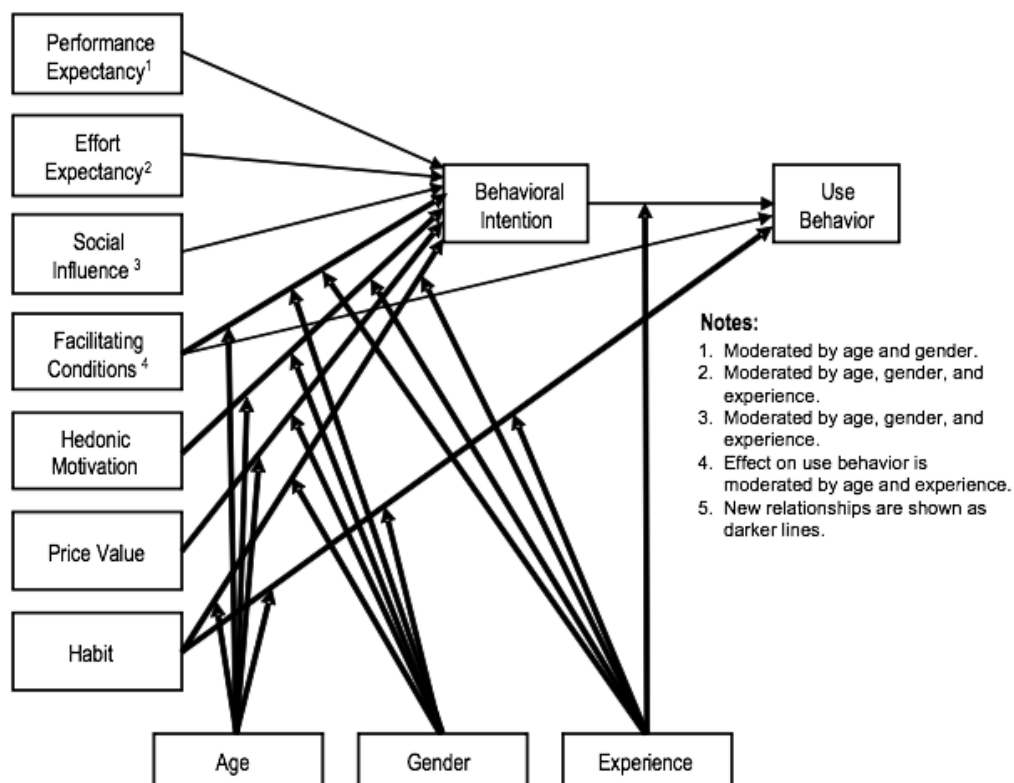


Figure 2-23 UTAUT2
(Venkatesh *et al.*, 2012)

2.5.2 Adoption and use of ICT by individuals and farming families

2.5.2.1 'Adoption and diffusion of innovations'

Information Systems models focused on specific ICT adoption in business or the consumer (UTAUT2) have been discussed in section 2.5.1. More broadly extensive research has been conducted on innovation. The process of learning about, understanding and utilising ICT is important (Leeuwis *et al.*, 2004). Between 1950 and 1970 especially, thousands of studies were conducted which sought to explain why and how people came to adopt, or not, new agricultural technologies and practices, reviewed by (Havelock and Arbor, 1973), generally in the context where the uptake of a particular innovation was deemed too slow. The stages of adoption characteristics most widely used are derived from Rogers (1962); Rogers (1971); Rogers (1983); Rogers (1995); Rogers (2003). Rogers's early books described stages in the innovation-decision process, built heavily on normative theories about decision-making models. His later books (Rogers, 2003; Rogers, 1995) supposedly reflect better about what happens in practice. The five stages consist of:

1. **Knowledge** occurs when an individual is exposed to an innovations' s existence and gains an understanding of how it functions;
2. **Persuasion** occurs when an individual forms a favourable or an unfavourable attitude towards the innovation;
3. **Decision** takes place when an individual engages in activities that lead to a choice to adopt or rejects the innovation;
4. **Implementation** occurs when an individual puts a new idea into use;
5. **Confirmation** takes place when an individual seeks reinforcement of an innovation-decision already made.

An important finding from the adoption research was that innovations are not adopted by everyone at the same time, with there being a pattern in the rate at which people adopted innovations. Some would usually adopt early, while others would adopt late. Adoption researchers typically classified people into five different categories:

- | | |
|-------------------|-------|
| 1. Innovators | 2.5% |
| 2. Early adopters | 13.5% |
| 3. Early majority | 34.0% |
| 4. Late majority | 34.0% |
| 5. Laggards | 16.0% |

Many researchers have investigated the relationship between an individual's adoption index and a variety of social characteristics. These studies have been conducted in highly diverse areas such as agriculture in industrialised and less industrialised countries, education, health services, and consumer behaviour, and were summarised in Rogers (1983), with similar results being found in all fields. Interestingly, age was not considered a characteristic with no relationship being found between adoption behaviour and age in about half of the studies and only one third of the remaining studies suggested that younger people were more innovative than older people.

Variable	% of studies	Number of studies
Education	74	275
Literacy	63	38
Larger size units	67	227
Social participation	73	149
Change agent contact	87	156
Exposure to interpersonal channels	77	60
More active information seeking	86	14

Table 2-15 Studies of relationships between adoption index and selected variables.
Adapted from Rogers (1983 p. 261)

Within the specific domain of ICT adoption by SMEs, recent studies utilising Rogers' model of innovation include Kendall *et al.* (2001) and Mehrtens *et al.* (2001). These two studies provide support for the applicability of the model when related to e-business engagement by SMEs. Many other authors have contributed qualitative studies on ICT adoption in SMEs and their work can be broadly separated into three themes: technological, strategic, and organisational. The technological theme views adoption as an outcome of a complex process of evaluation by SMEs of multiple internal and external factors, or enablers and barriers to adoption (Cragg and King, 1993; Dandridge and Levenburg, 2000; Mehrtens *et al.*, 2001; Windrum and De Berranger, 2003). The second theme emphasises the strategic logic in the decision to adopt ICT (Bili and Raymond, 1993; Daniel *et al.*, 2002; Rao Kowtha and Whai Ip Choon, 2001). The third theme takes an organisational stance often of the owner-manager and the social parameters within which the firm operates (Southern and Tilley, 2000).

Parker and Castleman (2007) undertook an extensive literature review of SME-eBusiness research conducted between the years 2003 and 2006 in 53 journals. This revealed a number of limitations in existing research such as the tendency to focus on SMEs themselves, without considering the complexity of relationships that many SMEs have with family, friends, other business and eBusiness providers. Agricultural adoption research

(Pannell *et al.*, 2006) has attributed adoption on a range of personal social, cultural and economic factors as well as on the characteristics of the innovation itself. Parker and Castleman (2007) recommended that future research needs to be more critical of the responsibility and ability of vendors, consultants and other providers to provide each individual, unique SME (farm) with a compelling business case to adopt an eBusiness (ICT) solution which matches their personal and business goals.

2.5.2.2 ICT adoption in agriculture

Whilst much is known of new technology adopters, little research has addressed the role of their attitudes in adoption decisions; particularly, for technologies with evident economic potential that have not been taken up by farmers (Rehman *et al.*, 2007). Modelling the agricultural decision-making process and information flow is nothing new. The primary objective of studies aimed at creating models is to determine why a given group of farmers behave the way that they do (Gladwin, 1989). Farmer attributes, objectives, personality, education, skills, current information management processes and learning style are associated with the use of computerised information systems. The size of business is also important through its potential impact on potential benefits (Alvarez and Nuthall, 2006). Cost effectiveness and improved herd management are drivers of adoption, whilst the threat to demean the personal knowledge and skills of a farmer in knowing their cows is a barrier (Rehman *et al.*, 2007).

While the development of technology is still largely driven by a need to address a problem, adoption is closely linked with other drivers of agricultural systems, most notably social, political and economic (Sassenrath *et al.*, 2008). Based on Apps and Idding (1990) and Taragola and Van Lierde (2010), a similar set of drivers was found by Alvarez and Nuthall (2006) in their study of dairying in New Zealand and Uruguay. Csoto (2011) summarises the factors affecting ICT adoption in agriculture to be:

- Farmer's characteristics (age, experience, personality, education);
- Community culture (network, associations);
- Farm characteristics (size, type, geography);
- Goals and objectives (attitude towards learning);
- Decision making and information management style (time, information sources number, intensity in use), extension usage, support for the outside);
- Trust in ICT;

- Service access/provision – The type of social and organisational infrastructure; links to local social networks, training facility availability.

Csoto (2011), after summarising factors affecting ICT adoption in agriculture, proposed changing perspectives. Instead of discovering the factors relating to ICT use among farmers, which concentrates on the use of the tool itself, rather to consider the information management style of the farmer, the channels and flow of information and its intensity. The suggestion was that the difference between farmers is not in the use of the tools (ICT), but rather their effective use with the assumption being that using ICT automatically makes the farming more efficient. Using or not using (ICT) is no longer an issue. The appropriate questions are rather: who uses ICT, how do they use it, and for what (Csoto, 2011).

Categories	Variables	
Socio-economic factors	Operator age	Formal education
	Years of farming experience	
Agro-ecological factors	Land tenure	Part-owner farmers
	Farm specialisation	Full-owner farmers
	Farm size	Farm income/profitability
	Farm sales	Soil quality
	Variable fertiliser rates	Percentage of main crop in total farmland
	Livestock sales	Percentage of farmland as country land area
	Debt-to-asset ration	Percentage of cropped land to total farmland
	Production value	Percentage of farmland as large farms
	Owned land minus rented land	
	Yield	
Institutional factors	Distance from a fertiliser dealer	Use of forward contract
	Region	Development pressure
Informational factors	Use consultant	Perceived Usefulness of extension services in implementing precision farming practices
Farmer perception	Perceived profitability of using precision agriculture	
Behavioural factors	Willingness to adopt variable-rate technology	
Technological factors	Yield mapping	Farm has irrigation facility
	Use of computer	Generated own map-based input prescription

Table 2-16 Factors influencing the adoption of PATs.
From various studies (Tey and Brindal, 2012)

ICT uptake in agriculture is continuing to be less than expected worldwide (Gelb and Voet, 2009; Alvarez and Nuthall, 2006; McBratney *et al.*, 2005; Lamb *et al.*, 2008). In many cases, new technologies have been produced through developer push rather than user pull with insufficient attention being paid to well-known technology adoption paradigms (Lamb *et al.*, 2008). As a consequence, the adoption of precision agriculture technologies is not as

great as it could be. Developers rather than users have stifled the adoption of Precision Agriculture technologies. Developer's priority "P's" are Positioning, Product; Pricing (hence profit), Placement and Promotion. Users priorities are Preparation, Protocols, Performance (hence Profit) and Perception. Rapid adoption required developers to pay as much attention to Protocols and Performance as the other listed priorities (Lamb *et al.*, 2008). Industry also has a support role in adoption of ICT, with research and industry good roles being important for adoption in emerging sectors such as the AMS market in Australia (Eastwood and Kenny, 2012). Industry good was defined by DairyNZ (2014) as an activity that is beneficial to dairy farmers that would not be undertaken by individuals or groups of dairy farmers because either it is too expensive for them to do on their own, or the benefits could not be captured by those making the investment. To reduce farmer uncertainty in early stages of new innovation (such as the emerging AMS market in Australia) support from industry (such as government and university research) to service providers is essential (Eastwood and Kenny, 2012; Alvarez and Nuthall, 2006).

Tey and Brindal (2012) review from an economic perspective factors explaining the adoptive decision making of Precision Agricultural Technologies (Table 2-16) and conclude that current models in the approach are not sufficient to represent the totality of those considerations which lead to the adoption of PATs, with past studies largely ignoring the informational, behavioural, and social aspects of decision making. The effective use of new technology is as important as the adoption. The achievement of effective use was adapted by Gurstein (2003) and includes:

- Carriage facilities – What telecommunications service infrastructure is needed to support the application being undertaken? For example, is broadband required or dialup;
- Input/output devices – What devices are required to undertake the activity? For example mobile application (app), or computer;
- Tools and supports – What software, physical supports, service supports are required;
- Content services – What specifically designed content is needed for particular application areas? Effective use implies content that is designed to be effective - useable, trustworthy, and designed for end users in an appropriate language;
- Social facilitation – What local resources, community and environmental infrastructure, training are required to locally enable the desired application or use;

- Governance – What is the required financing, regulatory or policy regime, either for governance of the application or to enable the implementation of the application. For example in the dairy industry there is a national herd database of cows, however for this database to be maintained, a financing system is required which allows for the reimbursement of the cost to local support services to maintain this database.

2.5.2.3 A larger perspective on ICT adoption

The influences on adoption in general have been studied intensely and are sufficiently well understood. Rather than more research into adoption, the more pressing need is to apply what is already well established in the adoption literature (Pannell *et al.*, 2006 p. 1421). Pannell *et al.* (2006), reviewed research on the adoption of rural innovations, and interpreted it through a cross-disciplinary lens to provide practical guidance for research, extension and policy. It was concluded that adoption depends on a range of personal, social, cultural and economic factors (p. 1410), as well as on characteristics of the innovation itself (p. 1410). Adoption occurs when the farmer perceives that the innovation in question will enhance the achievement of their personal goals (p. 1408). It is emphasised that innovations are more likely to be adopted when the innovations have a high relative advantage, perceived superiority to the idea or practise that it supersedes (p. 1414), and when innovations are readily triable, easy to test and learn about before adoption (p. 1419). Non or low adoption is readily explicable in terms of the innovations failure to provide a relative advantage (particularly in economic terms) (p. 1409) or a range of difficulties that farmers' may have in trialling the innovation (p. 1417).

Vanclay (1992a); Vanclay (2004) states there is no such thing as a barrier to adoption, there are only legitimate reasons for non-adoption and non-adoption will often make sense from the perspective of the non-adopting farmer. Because of the diversity of farmers and the existence of discrete styles of farming, new practices or technologies are rarely universally applicable (Howden and Vanclay, 2000; Mesiti and Vanclay, 2006; Vanclay *et al.*, 2006). Farmers' failure to adopt new techniques makes sense from the farmers' point of view (Vanclay, 1992a). Ten key barriers to adoption were identified by Vanclay (1992a) and further individually discussed in Vanclay (1992b). These are:

1. Complexity;
2. Divisibility. Divisibility allows for partial adoption. Farmers can adopt those parts of an innovation that they like or that are consistent with other farming objectives.

The more divisible into component parts an innovation is, the more likely it is to be adopted;

3. Congruence – incompatibility with farm and personal objectives;
4. Economics. Farmers do not necessarily act in a strictly economically rational way and many factors affect farmers' decisions to adopt new technologies, but reasonable to expect that the more economically beneficial an innovation, the greater the rate of adoption;
5. Risk and uncertainty;
6. Conflicting information – all new technologies are subject to debate about their applicability and effectiveness with farmers receiving information from numerous often conflicting sources;
7. Implementation cost – capital outlay;
8. Implementation cost – intellectual outlay. Farmers may have to learn new ways of doing things;
9. Loss of flexibility – innovations may reduce farmers' flexibility, with flexibility being useful to enable change required in response to market and climatic conditions;
10. Physical and social infrastructure (farming subculture).

2.5.3 Summary

This study contributes to the supply components of innovation diffusion research, investigating factors such as the effect of mobile phone reception and the availability of advice and support for ICT decisions and system implementation. A qualitative approach is undertaken in a traditionally quantitative field, addressing the criticism of Tey and Brindal (2012) that past ICT studies have largely ignored the informational, behavioural, and social aspects of decision making.

2.6 CHAPTER REFLECTIONS

This chapter has provided a review of selected literature deemed relevant in the areas of agriculture, family farms and sociocultural diversification, ICT use of the farm, and Adoption and use of ICT.

The Australian agricultural industry currently produces three times the food required for domestic use, and is well placed to benefit from projected increased world demand for

agricultural products. However to do this, the industry must overcome a broad range of barriers, of which the use of ICT can substantially assist. An example of this includes skill shortages where ICT can replace staff, work alongside staff, or enable staff of differing skillsets to be employed. Improved technologies and better management practices assisted by ICT are important for dairy farmers to avoid declining real farm incomes. Tasmanian family farm businesses are pasture based, minimal input systems that have a higher peak milk herd size than other states, with herd size increasing in all states. Tasmanian farms are generally more profitable than other states, and the farmers more positive about the industry. This research aimed to capture how these key farming characteristics interacted with the approach to and utilisation of ICT.

Investigating the unique qualities of family farm businesses is important in understanding how decisions are made, and the influences surrounding lifestyle and investment choices. Personal motivators for ICT use can flow over into the business because the business and personal life are fundamentally one-in-the-same. Other drivers for ICT use require an understanding of labour challenges associated with the agricultural industry and the changing future requirements. The agricultural research and extension support industries have spent many years and much research time trying to understand how farmers make decisions. Farmers have been categorised into types of adopters. Recent research about the style of farmers concludes that farming styles are more of an intellectual construction than a social construction. This topic is one that researchers do not consistently agree on. Tasmanian dairy farms are predominantly family owned, passed down through generations. This study aims to capture how family priorities, interactions and influences impact on decisions made in the family farm business. The literature has identified that there is a need to better understand the human factors associated with adoption of research in agriculture, which may include attitudinal and other characteristics of farmers. Particularly when seeking to understand management decision making on family farms, family influences must be considered. This research aims to address the need for a better understanding of the human factors associated with adoption in agriculture, specifically related to ICT.

Individual Tasmanian dairy farms utilise a diverse cross-section of ICT. The ICT ranges from robotic milkers and large computerised dairies, through to small enterprises with no computer herd management systems, or any ICT in the dairy. With this in mind, the study aimed to capture perspectives encompassing this diverse cross-section of farming systems.

The literature also identified rural communities as having reduced connectivity in the form of mobile and Internet access, with this having social and business implications. This research focused on capturing how current connectivity influenced family farm business and family life on a day-to-day level, as well as projecting forward perceived requirements and limitations in the future. Business and personal factors were considered, with family farm businesses by definition requiring an integration of both. The work undertaken in this thesis will extend the research of Dharma *et al.* (2012) by studying ICT as a source of information for farmers.

Parker and Castleman (2007) undertook an extensive literature review of SME-eBusiness research conducted between the years 2003 and 2006 in 53 journals. This revealed a number of limitations in existing research such as the tendency to focus on SMEs themselves without considering the complexity of relationships that many SMEs have with family, friends, other business and eBusiness providers. Agricultural adoption research (Pannell *et al.*, 2006) has attributed adoption on a range of personal social, cultural and economic factors as well as on the characteristics of the innovation itself. This study contributes to this field a qualitative approach in a traditionally quantitative field, addressing the criticism of Tey and Brindal (2012) that past ICT studies largely ignored the informational, behavioural and social aspects of decision making.

This research is located at the intersection of the three domains of Tasmanian dairy family farm businesses, Information and Communication Technology on dairy farms, and adoption and use of ICT. This research aims to explore the social and technological factors that drive ICT adoption in Tasmanian dairy family farm businesses. Chapter 3 provides a detailed discussion of the methodology adopted in addressing the research questions and associated research sub-questions stated in Section 1.3.2.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter describes the methodology adopted in addressing the research questions and objectives. This chapter is structured as follows:

- Section 3.2 describes the research framework developed in Chapter 2;
- Section 3.3 discusses the research philosophy making clear the ontology and epistemology adopted in this research;
- Section 3.4 discusses the research strategy employed, which consisted of a qualitative case study that collected data from members of Tasmanian dairy family farm businesses and their support industry;
- Section 3.5 describes in detail the research design that was guided by the research strategy and the philosophical orientation of the study;
- Section 3.6 describes the data collection techniques utilised to support the research design. Semi-structured interviews were utilised as the main data collection technique, supported by field notes, observation and/or industry documentation;
- Section 3.7 describes the approach employed to analyse the data from the interviews. Inductive thematic analysis, with the inclusion of open coding was utilised to identify themes that were then grouped into clusters;
- Section 3.8 deals with researcher bias, and the trustworthiness of the study by addressing credibility; transferability; dependability, and confirmability;
- Section 3.10 describes how the outcomes from the data analysis were interpreted and discussed in subsequent chapters;
- Section 3.10 provides a summary reflection of the chapter.

3.2 RESEARCH FRAMEWORK

As shown in Chapter 2, this research is located at the intersection of the three domains of Tasmanian dairy family farm businesses, Information and Communication Technology on dairy farms, and adoption and use of ICT (Figure 3-1).

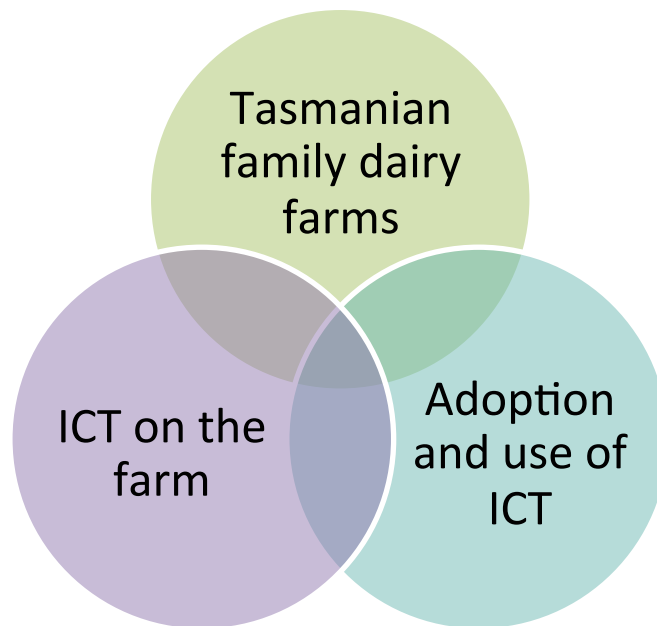


Figure 3-1 Research framework

Based on the review of adoption models presented in section 2.5 of the literature review, TAM3 was selected as being the most appropriate theoretical lens to use. The selection of this model is discussed in section 3.10.

The following sections of the methodology discuss the research philosophy and state the ontological and epistemological approaches adopted in this research.

3.3 RESEARCH PHILOSOPHY

This section describes the research philosophy underpinning the research. The researchers' view of the world influences how they obtain knowledge and hence their philosophical assumptions (Trauth, 2001).

3.3.1 *Ontology*

Ontology is the study of existence and reality and refers to the perceived nature of the world around us. Ontology addresses the issues of whether the empirical world is objective or subjective (Orlikowski and Baroudi, 1991; Burrell and Morgan, 1985). As stated by Chau (1986 p. 56) "the issue of ontology lies prior to and governs subsequent epistemological and methodological assumptions".

This research is a qualitative case study, explorative in design. Exploratory research is useful to "become familiar with the basic facts, setting and concerns" (Neuman, 2000 p. 22). A

preliminary review of the literature available pertaining to the use and adoption of ICT by dairy farmers indicated that predominantly previous research methods were quantitative surveys. While the use of surveys is suitable for creating categories or classifications, classifying a sequence of steps or stages and reporting on the background context of situations (Neuman, 2000), it does not provide a rich detailed insight into the researched phenomena. In order to obtain rich insight into the domain of ICT use on dairy farms, a subjective ontological approach was considered to be the most appropriate.

3.3.2 Epistemology

The term epistemology refers to the beliefs and assumptions in which knowledge is constructed and acquired (Cavaye, 1996). These beliefs relate to how one might begin to understand the world and communicate this knowledge to others (Burrell and Morgan, 1985). For this study, an interpretivist epistemology was adopted. Through exploring the phenomenon of ICT adoption and use, this research seeks to build an understanding of this phenomenon in the dairy industry.

The interpretivist approach is based on an ontology in which reality is subjective. It is a social product constructed and interpreted by humans as social actors according to their beliefs and value systems (Darke *et al.*, 1998). Interpretivist researchers believe that human interaction creates social circumstances and so they conduct studies to understand and describe the nature of the world using mainly qualitative research methods. Interpretivism seeks relevance in the research (Keen, 1991) by explicitly including an investigation of the context of the phenomenon under study. Utilising an interpretive approach for this research ensures that the researcher gains a deep understanding of the phenomenon under study while acknowledging the associated subjectivity.

Diffusion of innovation in the field of information technologies has been extensively explored and analysed through models and theories to attempt to predict factors affecting adoption and use based on individuals' expectancies and attitudes (Venkatesh *et al.*, 2003). By adopting an interpretivist epistemology, this research intends to examine the rich contextual data obtained as much as possible without forming any preconceived ideas.

3.4 RESEARCH STRATEGY

The aim of this research is to explore the social and technological factors that drive ICT adoption in Tasmanian dairy family farm businesses. As such, the research strategy consisted of a qualitative case study adopting semi-structured interviews of farmers throughout Tasmania and of the industry supporting these farmers.

This research employed a strategy involving qualitative semi-structured in depth interviews to explore the topic in depth. The strategy involved three key elements:

- Qualitative research;
- Case study approach;
- Boundaries of the study.

3.4.1 *Qualitative research*

Qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live. Denzin and Lincoln (2005 p. 3), explain that qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study social issues in their natural settings, attempting to make sense of or interpret phenomena in terms of the meaning people bring to them.

Kaplan and Maxwell (1994), contend that the goal of understanding a phenomenon from the point of view of the participants and the particular social and institutional context is largely lost when textual data are quantified.

Many aspects of qualitative research suggest a qualitative approach as being best suited to this research. Creswell (1998), presents strong reasoning for the adoption of a qualitative approach in this research:

- The research questions focused on “what and how”, therefore examining what is going on in family farm businesses. The nature of the research questions aligns with a qualitative study;
- As previously stated the research is exploratory in nature with the objectives being to understand how and why family farm businesses interact with ICT.

A qualitative methodology was chosen for the research described in this thesis because it fitted in with the research aims. The researcher identified a need for qualitative in-depth interviews to facilitate a comprehensive whole, or integrated systems understanding of the

social and technological factors that drive ICT adoption in Tasmanian dairy family farm businesses. The view that such research is needed is supported by DAFF (2007) who identified that better understanding of human factors in the adoption of research in the agriculture and food industries is important to ensure intended research and development outcomes are achieved. A review of literature concerning the adoption of ICT in agriculture found the majority of the studies to be survey and quantitative in nature (Gelb and Voet, 2009; Alvarez and Nuthall, 2006), which is reflective of broad innovation, adoption, and acceptance and diffusion research. Williams *et al.* (2009), concluded innovation adoption, acceptance and diffusion research over a 22 year period was predominantly empirical and quantitative, revealing clear opportunities for researchers to make original contributions by making greater use of theoretical and methodological variety.

3.4.2 A Case study approach

Case study research may involve a positivistic (Benbasat *et al.*, 1987; Lee, 1989; Yin, 1989) or interpretative epistemology, employing either quantitative or qualitative methods or a combination of the two. Although past Information Systems researchers have used case study research in a positivistic manner there has been a notable increase in an interpretivist use of case study research (Walsham, 1995). Interpretative case studies have been widely used in the social sciences (Silverman, 1998), and have gained wide acceptance in the Information Systems discipline. Although Yin (2003) supported the use of case research from a positivist perspective, his belief that case studies can be best used to explore “how” and “why” questions supports an interpretivist approach to using case study strategy (Walsham, 1995).

The case study approach has the capacity to bring four dimensions to Interpretivist research (Urquhart, 1999). It has the ability to:

- Produce rich insights from the data;
- Draw specific implications;
- Develop concepts within the data; and
- Provide a base to generate theory.

Specifically, through the ability to produce rich insights from the data the use of a case study approach provides a coherent strategy to explore the influence of the social and technological context on the adoption and use of ICT by family dairy farms in Tasmania.

Family farm businesses are complex, individualistic, holistic systems due to their nature of being integrated into the family entity. Family businesses provide the opportunity for dynamics between generations which influence how and why things are done. Additionally, the farm and family life are intertwined, creating a unique environment in which decisions are made. For this reason 33 farmers were interviewed to provide an in-depth grounded view to ensure many perspectives and family situations were included. Six industry interviews were also conducted to provide an alternative lens in recognition that external factors, some of which farmers may not be aware of, are important. This provides an alternative perspective for the research.

3.4.3 Boundaries of the study

A case study is an exploration of a “bounded system” over place and time (Creswell, 1998). For this case study the research was bounded by the industry of dairy farming, the location of the state of Tasmania, and the time period of 2011. The type of farm business structure studied was the family farm business, and the industry representatives interviewed were restricted to those that were relevant to the farmers studied. The area of interest was the use of ICT by these farmers:

- Dairy farming: Dairy farming was selected exclusively due to the fact that dairy farming is the most intensive of the grazing animal production systems, and therefore it has the most opportunity for Information and Communication Technology (ICT) to have a significant effect on the industry. Substantial ICT has been developed for the dairy industry providing the potential for large investment and management changing decisions if utilised;
- Tasmania: Is the only state or territory of Australia to be totally surrounded by water (240km of water at the narrowest point). This provides the opportunity to study the effect of isolation and remote support options, with many businesses basing their support services in Victoria.

Tasmania has the largest peak herd size of all the states in Australia. This larger herd size is an indication of the trend Australia-wide, and makes Tasmania an ideal location to study for the future benefit of all of Australia.

Tasmania is a growth state for dairy farming in Australia (Dairy Australia, 2011a). The dairy industry in Tasmanian is considered to have excellent expansion opportunities compared to

other states in Australia due to irrigation expansion opportunities, and the natural climate. This makes Tasmania an important location to study:

- Time: The research was conducted during the calendar year of 2011;
- Family farm businesses: Family farm businesses were selected for this research. Owner-operated, or family farms dominate the Australian dairy industry, with corporate farms making up just 2% of the total (Dairy Australia, 2012a). Corporate farms do not have family-related priorities influencing decisions and were therefore not included in this research;
- Industry interviewed: Industry interviews were restricted to those businesses or organisations that provided services or product directly to the farmer. These businesses may be based in another state, or have their head offices based in another state.

In summary, section 3.3 presented the strategy involved in spending time with Tasmanian dairy farmers to become familiar with the reasons surrounding ICT use. A qualitative, bounded case study approach was selected to provide insight into the research question and in-depth grounded data.

3.5 RESEARCH DESIGN

This section describes the research design that was guided by the research strategy (Section 3.3) and the philosophical orientation of the study (section 3.2). Information Systems literature contains a significant number of interpretive case studies, such as those reviewed by Orlikowski and Baroudi (1991). This section aims to describe the nature and conduct of the case study method.

A dual approach was selected, with a primary focus of farmers, and an alternative lens of Industry, to incorporate multiple perspectives in the research.

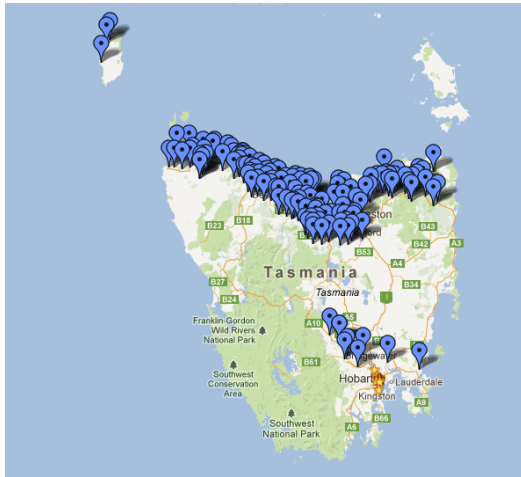


Figure 3-2 Graph of location of all Tasmanian Dairy Farmers
Source Tasmanian Institute of Agriculture – TIA 2011

3.5.1 Selection of farmers

There are 444 registered dairy farms in Tasmania (Dairy Australia, 2012a). A map of Tasmanian dairy farm locations is presented in Figure 3-2. A database of Tasmanian dairy farms sourced from the Tasmanian Institute of Agriculture (TIA) was divided into six dairying areas (Far North West; North West; North; North East, South and King Island), however the King Island farmers were not interviewed due to financial constraints of the researcher. The average herd size in Australia is estimated to be 247 cows (Dairy Australia, 2013a), with the 2012 National Dairy Farmer survey indicating that 11% of dairy farms had herd sizes of more than 500 cows (Dairy Australia, 2012a). In Tasmania the average herd size is 327 cows (2011/2012 season) (Dairy Australia, 2013a). Previous research (Alvarez and Nuthall, 2006; Tiffin and Balcombe, 2011; Tey and Brindal, 2012) has identified larger farm or herd sizes as a positive factor in ICT adoption. To account for this, and to investigate the effect of herd size further, large and small or average sized herds for each area were selected, with more farmers being interviewed in the North and North West due to the larger farmer population base, with a herd size of 500 cows or above being defined as 'large'. Thirty-three farms were selected to provide an opportunity for the diversity of dairy farms to be captured in the research (farm locations are shown in Figure 3-3). Two Automatic Milking System (AMS) farms were operational in Tasmania at the time of the data collection, and these farms were specifically included in the data collection to provide an alternative future perspective. Farmers were left to self-select who the representative(s) from their business would be, with this range resulting in between one and three persons being interviewed per farm. This ensured perspectives from all

generations, male and female, and additionally provided an opportunity to observe the interaction between family members.

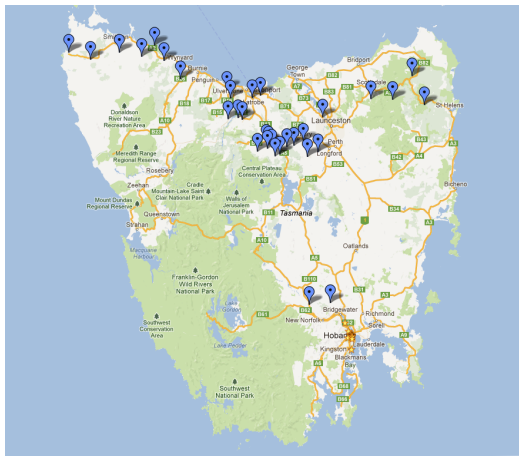


Figure 3-3 Location of farms visited during data collection

3.5.2 Selection of Industry representatives

Victoria is the base for the Australian dairy industry, including funding bodies, industry bodies, and commercial service providers. This is because it is the largest dairying state in Australia, with 4,556 registered dairy farms (1,059,000 head of dairy cattle), compared to 2,214 farms (571,000 head) in all the other states combined (Dairy Australia, 2012a).

Industry interviewees were selected for their involvement in and knowledge of the Tasmanian Dairy Industry, utilising the researcher's knowledge of the industry. The industry interviews provided an additional perspective and lens on the research topic and included multinational companies represented in Australia, a locally owned commercial company, farmer-owned service providers, and an industry service body. All interviews were face-to-face with five of the six interviews conducted being in Victoria, and one in Tasmania, due to the fact this is where the head offices of the organisations are based. Suppliers of herd management software provide cow and herd data backup services which are based in Victoria.

3.6 DATA COLLECTION TECHNIQUES

This section describes the data collection techniques utilised to support the research design (section 3.4). The data analysis process will be described in section 3.6. Semi-structured interviews were utilised as the main data collection technique, supported by field notes and documentation of observations.

3.6.1 Farmer data collection

Semi-structured interviews were utilised as the main data collection technique, supported by observation and field notes. In an Interpretivist study interviews should be the primary source of data (Walsham, 1995) but should be supplemented with other forms of field data (Walsham, 2006).

3.6.1.1 The interview process

Farm	Farm location (Tasmania)	Herd size	Internet type	Number of generations farm run by currently	Farmed by previous generations	Interviewed
1	North East	350	Wireless	2	Yes	Father and son
2	North East	300	Satellite	1	No	Husband and wife
3	North West	108-120	Satellite	1	No	Wife
4	Far North West	300	Satellite	2	Yes	Husband and some wife input
5	North West	300	ADSL	2	No	Husband and some wife input
6	North West	160 year round	Wireless	1	No	Wife
7	North West	180	ADSL	1	Yes	Wife
8	North	830	ADSL	1	Yes	Husband and wife
9	North	280	Satellite	1	Yes	Wife
10	North	280	Satellite	1	Yes	Son and some father
11	North	150 aim 250	ADSL	1	No	Husband
12	North East	840	Satellite	1	Yes	Husband and wife
13	North West	650	Wireless	2	No	Husband and wife
14	North	320	Satellite	2	Yes	Husband
15	North	500 spring 100 Autumn	Satellite	2	Yes	Husband
16	North West	50	Wireless	1	No	Husband and wife
17	North	400	Satellite	1	Yes	Husband
18	North	380 aim 500	Wireless	1	Yes	Husband
19	North	420	Wireless	2	No	Husband and wife
20	North	720	ADSL	2	Yes	Son
21	North West	62	Daughter's (different location)	1	No	Husband
22	North	550	Satellite	2	No	Husband, wife and son
23	North	180-220	Son has Internet on phone	2	Yes	Husband, wife and son
24	North	210	Satellite	2	Yes	Husband and wife
25	South	340	ADSL	1	Yes	Son and some wife
26	North West	190 peak 120 winter	No	1	Yes	Husband and wife
27	North West	450	Wireless	2	Yes	Son
28	North West	650	Satellite	1	Yes	Husband
29	North West	480	Satellite	1	No	Husband and wife
30	North West	220	Wireless	2	Yes	Wife
31	Far North West	210	Satellite	2	No	Husband and wife
32	South	830	Wireless	1	Yes	Husband
33	North East	250	Satellite	1	Yes	Husband

Table 3-1 Demographics of farmers interviewed

Farm number	Research purchases online	Buy online	Reception issues	ICT in shed	Robotic calf feeder	Don't trust ICT for animals	Internet speed problems	NBN interest	Telstra because of reception	Complexity/compatibility	Lifestyle priority	No ICT in shed due to cost	Females role on farm	Females ICT influence
1	Y	Y	N	Y	N	N	N	Far	Y	N	Y	G	Lives in town	Equal
2	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y	N	On farm	Equal
3	Y	N	Y	N	N	Y	N	N	Y	N	Y	WD	On farm	Driver
4	Y	Y	Y	Y	N	N	Y	Far	Y	N	Y	G	Off farm	Equal
5	Y	Y	N	N	N	N	Y	Y	Y	N	Y	N	On farm	Equal
6	Y	Y	N	N	N	Y	Y	Y	Y	N	Y	N	On farm	Equal
7	Y	Y	Y	N	N	N	Y	N	Y	-	Y	Y	On farm	Equal
8	Y	Y	N	N	N	N	N	Far	Y	N	Y	Y	On farm	Equal
9	Y	Y	Y	N	N	N	Y	Far	Y	Y	Y	Y	General	Equal
10	Y	Y	N	N	N	N	Y	Y	Y	N	Y	Y	Off farm	Male driver
11	Y	N	Y	N	N	N	N	Y	Y	Y	Y	INST	Off farm	Equal
12	Y	N	Y	Y	N	N	N	N	Y	Y	Y	G	General	Driver
13	Y	Y	N	N	N	N	N	Y	Y	N	Y	Y	On farm	Equal
14	N	N	N	Y	Y	N	N	N	Y	N	Y	G	Off farm	Smart ICT
15	N	N	Y	N	N	N	N	N	Y	Y	Y	Y	General	Equal
16	Y	Y	N	N	N	Y	N	N	Y	N	Y	Y	On farm	Equal
17	Y	Y	Y	Y	N	N	Y	Far	Y	Y	Y	G	Lives in town	Equal
18	Y	Y	N	Y	I	Y	N	N	Y	N	Y	Y	Off farm	Equal
19	Y	Y	Y	Y	I	N	Y	Y	Y	N	Y	Y	General	Herd management
20	Y	N	N	N	Y	N	N	N	Y	N	Y	N	Off farm	Driver
21	N	N	N	N	N	N	-	N	Y	N	Y	N	-	-
22	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	G	On farm	Male driver
23	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	INST	General	Equal
24	Y	Y	Y	N	Y	N	Y	Y	Y	N	Y	Y	Off farm	Smart ICT
25	Y	Y	Y	N	Y	N	Y	Far	Y	Y	Y	N	General	Smart ICT
26	N	N	N	N	N	N	-	N	Y	Y	Y	Y	On farm	Equal
27	Y	N	Y	N	N	N	Y	Far	Y	Y	Y	N	General	Male driver
28	Y	N	Y	N	N	N	Y	Far	Y	Y	Y	Y	Off farm	Smart ICT
29	Y	Y	Y	N	N	N	Y	N	Y	-	Y	Y	On farm	Equal
30	Y	Y	N	Y	N	N	N	Y	Y	N	Y	Y	Off farm	Driver
31	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	G	On farm	Equal
32	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	G	Off farm	Smart ICT
33	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	G	General	Male driver in Shed. Female driver smart ICT

Table 3-2 Demographics of farms interviews.

Y = Yes; **N** = No; **I** = Interested; - = not applicable; **Far** = Too far away to think about;

INST = Installing currently; **WD** = winding down; **G** = Got ICT in shed;

Lives in Town = lives in town during the week with the kids due to schooling; **General** – General farm involvement, predominantly not on-farm; **Off farm** = works off farm.

Equal = Equal ICT between male and female, **Driver** = main driver of ICT in farming business. **Smart ICT** – driver of use of smart phones especially; **Herd Management**: Looks after herd management software; **Driver** = Female main driver of all ICT use.

Interviewing provides multiple views on a case under investigation (Stake, 1995). The expectation is that people see things differently and therefore how multiple people view an object or event will provide insight into how participants understand experiences and reconstruct events in which the researcher did not participate (Rubin and Rubin, 2005). Thirty-three semi-structured interviews ranging in length from 45 minutes to 2½ hours were conducted. Semi-structured interviews provide flexibility in the use of open-ended questions to explore experiences and attitudes (Pope *et al.*, 2002). The interview questions were formulated to encourage participants to discuss issues relating to the research without imposing any limitations or constraints as to how the questions may be answered (Doolin, 1996).

Farmers were contacted by phone, the research explained, and were invited to participate. If farmers agreed, a convenient time was arranged for the researcher to visit the farm and conduct the interview, with all interviews being conducted face-to-face. Farmers self-selected which members of the family were to participate in the interviews. Participants ranged in number from one to three members of the family, with both sexes represented. Demographics of participants interviewed are described in Table 3-1 and Table 3-2. While these tables provide basic demographics of the family farm businesses interviewed, it is important to remember that family farm businesses are individually unique, complex and dynamic enterprises. For example Farm 3 supports three families (parents and their two sons and their families); Farm 4 has two generations working on the farm, however the son is not interested in cows and is expanding the vegetable growing component of the farm; and Farm 28 is run by two brothers and their families.

The interview location was generally the 'kitchen table', with two interviews occurring at an office attached to the milking shed. Generally two different farmer interviews were arranged per day – one after morning milking, and the other early afternoon before afternoon milking, with interview times varying between 45 minutes and 2½ hours. To ensure that the information being presented was accurately recorded, an Olympus DS-4000 digital recorder was used to record the interview. Permission from interviewees to record

the interview was granted before use. At the completion of the interview the recordings were transcribed as soon as possible, in preparation for data analysis. Transcription was done by the researcher listening to the interview recording and either directly typing into a word document, or using Dragon Naturally Speaking 11.0 to convert the researcher's voice into text in a Microsoft word document. The speed and position of the recording was controlled using NCH Express Scribe. During transcription the researcher used memos, which were utilised during the interpretation and discussion.

3.6.1.2 The Farmer question format

A semi-structured question format was used to gather information about the use of ICT by the interviewed dairy farmers (see Appendix 1). The questions were formulated to encourage participants to discuss issues relating to the study without imposing limitations or constraints on how the questions may be answered (Doolin, 1996). The broad sections of the question frame were arranged as follows:

Section 1: Background

The aim of this section was to provide background information relating to the farm such as the physical size, number of cows, staffing, personal background, and the history of the farm. The aim of this section was two-fold: collect background information on the farm, and develop rapport with the farmer. Farmers are accustomed to describing the physical aspects of their farm, so this was used as an ice-breaker for conversation, while providing the researcher with a 'feel' for the farm. Some of the first, and potentially most important steps that researchers must take in the field are those related to rapport development with their participants (Pitts and Miller-Day, 2007). Rapport was also built with the participant by the researcher providing a brief background of how she came to be involved in the research. The researcher expressed no judgment about the responses to questions, therefore introducing no bias into the interviews, or leading of the interviewee.

Background topics included:

- What is the physical size of your farm?
- How many cows do you milk peak season (and do you milk year round)?
- What is the ownership and management structure of the farm?
- Who is involved with the farm, and what is their role (family, paid staff)?
- How did you come to be involved in this property? (is this a family farm, or was it purchased, including work and education background)

Section 2: Current ICT use on farm

This section began with a discussion on the definition of ICT. Farmers were most comfortable, once a definition was provided with referring to ICT simply as 'technology'. The aim of this section was to explore all areas of ICT ('technology') use on farm. These included:

- The use of ICT on the farm: This includes what ICT is being used, why the ICT is being used, and how the decision is made to implement the ICT. Any ICT that is available but is not being used is also discussed, and the reasons around this are explored. Specific topics include:
 - The milking shed;
 - Farm management (such as herd management software) including how the data inputting is managed if used;
 - Irrigation.
- Internet: What type of Internet is used, why? This includes the perceived satisfaction with the current level of service, both connectivity and speed. Additionally 'what is the Internet used for' was discussed;
- Mobile phones: The use of mobile phones and smart phones (if applicable);
- Knowledge growth and influences: How does the farmer go about finding out information? Is this information gathering for purchasing, or technical farm management decisions?

Section 3: Future

The aim of this section was to provide an opportunity for the farmer to give their view of the future of the Australian Dairy Industry, and to for the farmer to raise any topics they felt were relevant that had not been covered in the interview by the researcher. The areas of discussion included:

- Future milking systems, including AMS for the dairy industry in Australia and its relevance to the interviewee;
- The outlook of the Australian Dairy Industry for the future;
- The influence of ICT on the future of the Australian dairy industry.

Section 4: Conclusion

The purpose of this section was to 'wrap up' the interview, summarise what was discussed in the interview, and ensure the farmer was presented with the opportunity to raise any additional points that they wished to discuss.

3.6.1.3 The Farmer interview experience

Farmers were always happy to talk. This was assisted by the interviewer being able to relate to the farmers, having worked in the industry for ten years. Additionally, the interviews were purposely planned for a generally non-busy time of the farming year – late summer when milking does not take long, and milking and feeding are the only essential jobs for the day. This is in comparison to the busy late winter and early spring calving season, the spring mating season, and the early summer silage and haymaking. Interview times were selected by the farmers to fit in best with their daily jobs, with the times selected being after milking in the morning or at lunchtime. At the end of each interview the researcher checked through the major points of the interview with the farmer. This helped to ensure that the information was correct and reduced the chance of misinterpretation. The farmer was also given the opportunity to discuss any additional topics they wished to.

3.6.1.4 Research field notes

Field notes were used in the research to support the data collection. Either directly after the interview, or each night the interviewer made reflection notes on the interviews completed that day in an electronic format (Oates, 2006). The observations and reflections contained within the field notes were used to provide clues and strategies for recalling the data (Berg, 2004).

The field notes captured observations made during the semi-structured interview as well as the researcher's reflections, personal comments and thoughts about the interview. These were later collated and used to provide deeper understanding during the interpretation and discussion.

3.6.1.5 Researcher observations

Observations were used as a data collection technique to gain an insight into the running of the farm and how the farmer and their family used any ICT present on the farm.

Atkinson and Hammersley (1994), draw a distinction between participant and non-participant observation by developing a fourfold typology:

- The complete observer – the researcher remains in the background and watches and listens;
- The observer as participant – the researcher participates as if an organisational member;
- The participant as observer – the researcher participates fully but overtly as a researcher;
- The complete participant – the researcher acts as an organisational member.

The researcher took on the role of a complete observer in the 33 farmer interviews. The researcher initially observed the farm itself – the presentation, layout and impressions of infrastructure such as the milking shed. The interview setting itself was observed for - such as mobile phones lined up on windowsills and the observation of other family members' use of ICT during the interview. The farmer's interaction with ICT was observed, such as the visual reference to, location of, and use of their mobile during the interview, and if they were required to move to another part of the house to answer their mobile if it rang. Observations were documented in the field notes, and used in the observation and discussion chapters to enhance understanding.

3.6.2 Industry data collection

Semi-structured interviews, field notes, and documentation were utilised as data collection techniques for industry data collection, with semi-structured interviews forming the core data set, as for the farmer interview process.

3.6.2.1 The interview process

Interviewing provides multiple views on a case under investigation (Stake, 1995). The expectation is that people see things differently and therefore how multiple people view an object or event will provide insight into how participants understand experiences and reconstruct events in which the researcher did not participate (Rubin and Rubin, 2005). Six semi-structured interviews ranging in duration between 30 minutes and two hours were conducted. Semi-structured interviews provide flexibility in the use of open-ended questions to explore experiences and attitudes (Pope *et al.*, 2002). The interview questions were formulated to encourage participants to discuss issues relating to the research without imposing any limitations or constraints as to how the questions may be answered (Doolin, 1996).

Initial contact was made by phone to businesses, and businesses self-selected the most appropriate person(s) for the researcher to interview. A description of industry interviewed is presented in Table 3-3. Self-selected interviewees ranged from directors, through to staff directly dealing with the farmers on a day-to-day basis. All interviews were conducted face-to-face, and took place either at the place of business, or at a mutually convenient place such as a coffee shop. Interview length ranged from 30 minutes to two hours. To ensure that the information being presented was accurately recorded, a digital recorder was used. Permission from interviewees to record the interview was granted before use. In all instances reflection notes were taken at the conclusion of each interview, when the researcher returned to the car or home for the night. The researcher reflected on the conversation and retained personal comments and thoughts about the interview. These were later collated and used to provide understanding in the interpretation. At the completion of the interview the recordings were transcribed as soon as possible, in preparation for data analysis. Transcription was done using NCH Express Scribe and Dragon Naturally Speaking 11.0 to convert spoken words into text in a Microsoft Word document. During transcription, the researcher used memos, which were utilised during the interpretation and discussion.

Industry	Industry Category	Domestic or International based
A	Dual service and commercial	Domestic
B	Industry body	Domestic
C	Commercial	International
D	Commercial	Domestic
E	Service industry	Domestic
F	Commercial	International

Table 3-3 Description of Industry interviewed

3.6.2.2 The Industry question format

A semi-structured question format was used to gain insight into industry representatives' experiences with farmers' use of ICT (see Appendix 2). Industry representatives through their daily interaction with Tasmanian dairy farmers were able to offer their perceptions on factors surrounding ICT use on farm, and were also willing to be analytical towards themselves and the industry as a whole.

The broad sections of the question frame were arranged as follows:

Section 1: Background

The aim of this section was to provide background information on the company and the participant's role in the company. Some of the first, and potentially most important steps that researchers must take in the field are those related to rapport development with their participants (Pitts and Miller-Day, 2007). Rapport was built with the participant by the researcher providing a brief background of how she came to be involved in the research. The researcher expressed no judgment about the responses to questions, therefore introducing no bias into the interviews, or leading of the interviewee.

Section 2: Current use of ICT on the dairy farm

This section began with a discussion on the definition of ICT, and the boundaries for the discussion (Tasmanian Dairy Farmers). This section explored all areas of ICT use on the farm, particularly shed and herd management software. The industries perceived issues surround the use of ICT on farm were discussed.

Section 3: The role of Internet

This section discussed farmers currently Internet usage, whether current access to Internet on-farm was limiting, the use of the Internet in technical support provision, and their anticipated future industry and farmer requirements.

Section 4: The role of smart phones and PDA's

This section discussed the current and future use of smart phones by farmers, farmer demand for smartphone applications 'apps', and whether industry considered this to be an important area of development.

Section 5: Farmer sourcing of information

This section discussed how farmers were sourcing their information to make ICT purchasing decisions.

Section 6: Future

This section allowed the industry participant to raise any topics not mentioned that they wished to discuss. Additionally, this section provided the opportunity to gain an insight into where the industry perceived the future to be for ICT on-farm, and the factors influencing this.

3.6.2.3 Industry field notes

Field notes were used in the research to support the data collection. Either directly after the interview, or each night the interviewer made reflection notes on the interviews

completed that day in an electronic format (Oates, 2006). The observations and reflections contained within the field notes were used to provide clues and strategies for recalling the data (Berg, 2004).

The field notes captured observations made during the semi-structured interview as well as the researcher's reflections, personal comments and thoughts about the interview. These were later collated and used to provide deeper understanding during the interpretation and discussion.

3.6.2.4 Industry documentation

The collection of documentation, such as DVDs and books on services and technology provided by industry interviewed, provided both primary and secondary sources of data. Semi-structured interviews and field notes may not have provided sufficient information on their own to produce answers (Berg, 2004). The documentation gave insight into technology available to the farmer, and also how this material is presented. These were used to inform the researcher during interpretation and discussion of data.

This section has presented the data collection techniques used to collect the data and to support the research strategy (section 4.3) and the research design (section 4.4). The next section presents the data analysis methods adopted.

3.7 DATA ANALYSIS

This section describes the approach employed to analyse the data from interviews. Qualitative analysis starts with choosing the research method based on the research question that needs answering. The research question was 'what are the social and technological factors that drive ICT adoption in Tasmanian dairy family farm businesses'. The method adopted has been designed to allow individual farmers voices to be heard as individuals. Farmer individuality came through strongly during the interview process, and it was important to respect and retain this uniqueness providing a broad and deep view of dairy farming in Tasmania.

Data collected through qualitative methods such as interviews is often unstructured and can be hard to manage. Data analysis is the process of bringing order, structure and meaning to the masses of collected data (Marshall and Rossman, 2006). The challenge faced by all qualitative researchers is to "make sense of massive amounts of data, reduce the volume of information, identify significant patterns and construct a framework for

communicating the essence of what the data reveal” (Patton, 2002). Data analysis is the breaking down of data to reveal its characteristic structure and elements (Dey, 1993). There are multiple facets and approaches to data analysis encompassing diverse techniques and there is no one ‘right’ approach (Coffey and Atkinson, 1996; Tesch, 1990). The choice of analytic approach is influenced by a number of factors, including the particular research goals and questions being asked and the methods used for data collection, as well as the types of data available for collection and investigation (Coffey and Atkinson, 1996). The act of selecting the most appropriate techniques can be viewed as the start of the analysis, and is essential to the analysis (Huberman and Miles, 1994). Description is the basis for analysis, but through analysis a different view of the data can be gained. Accordingly analysis is an iterative process, with each iteration of analysis offering a new perspective on the data (Dey, 1993). In this research, the data collected has been analysed systematically using thematic coding (Boyatzis, 1998) guided by open coding (Strauss and Corbin, 1990). Similar events (concepts) were grouped to form categories (themes). The coding process was about conceptualising the data (Strauss and Corbin, 1990).

Detailed data analysis is presented in Chapters 4 and 5 of this thesis. Farmer and industry interviews were analysed separately (Chapter 4 and Chapter 5), and combined in the interpretation and discussion (Chapter 6) and findings (Chapter 7).

3.7.1 Analysis

The interviews were analysed systematically using thematic coding (Boyatzis, 1998) guided by open coding (Strauss and Corbin, 1990). ‘Coding means that we attach labels to segments of data that depict what each segment is about’ (Charmaz, 2006 p. 3). Strauss and Corbin (1990), state that if the purpose is to identify themes in the data then open coding will suffice to produce that outcome.

“Although if your purpose is just to pull out themes, then you could pretty much stop here [categories] (Strauss and Corbin, 1990, p 67)

Rice and Ezzy (1999), describe thematic coding as being similar to grounded theory. They propose that thematic coding and content analysis are closely related, with the main difference between the two that the codes are predefined in content analysis. Boyatzis (1998), described a framework for thematic coding which aligns more to a positivist perspective. To maintain an objective nature in the resulting themes, no predefined codes were developed, with the codes being grounded in the data. This research produced

themes grounded in the data, drawing upon techniques from Strauss and Corbin (1990) to conceptualise the data and thematic coding (Boyatzis, 1998), facilitated a final conclusion to be drawn (Huberman and Miles, 1994).

Boyatzis (1998), while adopting a positivist view to data analysis, states that:

“A good thematic code is one that captures the qualitative richness of the phenomenon. It is usable in the analysis, the interpretation, and the presentation of research”. (Boyatzis, 1998 p. 31)

The following data analysis method has been adopted for both farmer and industry interviews, which were analysed separately.

3.7.1.1 The coding process

Coding provides a mechanism for looking at the data in a new way while at the same time coping with the task of data reduction (Huberman and Miles, 1994). Qualitative studies require the analysis of large amounts of data. The process of coding provides structure for the research to probe into the data, allowing the production of more than just surface themes. This process also provides a means of breaking through preconceived biases and assumptions, resulting in the outcomes being grounded in the data (Strauss and Corbin, 1990).

The coding process broke the data into discrete parts (summary codes), helping to create the basic building blocks where knowledge was created. Similar events (concepts) were grouped to form categories (themes) to enable examination of their properties and dimensions. The purpose of the coding process was conceptualisation of the data (Strauss and Corbin, 1990).

Boyatzis (1998 p. 45), provided a framework of a step by step approach for thematic coding:

1. Reducing the raw information;
2. Identifying themes within subsamples;
3. Comparing themes across subsamples;
4. Creating a code;
5. Determining the reliability of the code.

This method was adapted by Ellis (2009) to incorporate open coding (Strauss and Corbin, 1990), to ensure that the themes were grounded in the data. Strauss (1987) described open coding as the first pass through the data. This first pass through the data results in the production of conceptual labels. The first pass may involve a number of iterations before reaching the production of themes. This studies framework consisted of:

1. Data reduction to produce summary codes (Boyatzis, 1998);
2. Summary codes grouped to produce conceptual labels (Strauss and Corbin, 1990);
3. Conceptual labels grouped by links and relationships to produce thematic codes (Boyatzis, 1998).

The researcher adopted this methodology, with the additional final step in the coding process of:

4. Grouping of themes to clusters by theme concept (Boyatzis, 1998).

These four steps will be discussed in further detail in the following sections.

STEP ONE – PRODUCTION OF SUMMARY CODES

In the first iteration, the researcher reduced the data by condensing or summarising the data, producing summary codes.

“Reducing the raw information may not result in fewer pages or fewer lines but will give it a shortened “outline” form, easier for comparison across units of analysis”. (Boyatzis, 1998, p. 69)

Highlighted Transcript Text

Corresponding Summary Code entered here

List of Interview files

Individual transcript file

Figure 3-4 Data Reduction of Transcripts using NVivo 9.

Source: NVivo, personal file.

NVivo was used as a tool to manage the first data reduction stage to produce summary codes. Transcripts in the form of Microsoft Word documents were imported into NVivo. Each of the farmer and industry interview transcripts were coded individually at the phrase level using NVivo. This was done by systematically working through each transcript, highlighting phrases and entering a summary code, as shown in Figure 3-4.

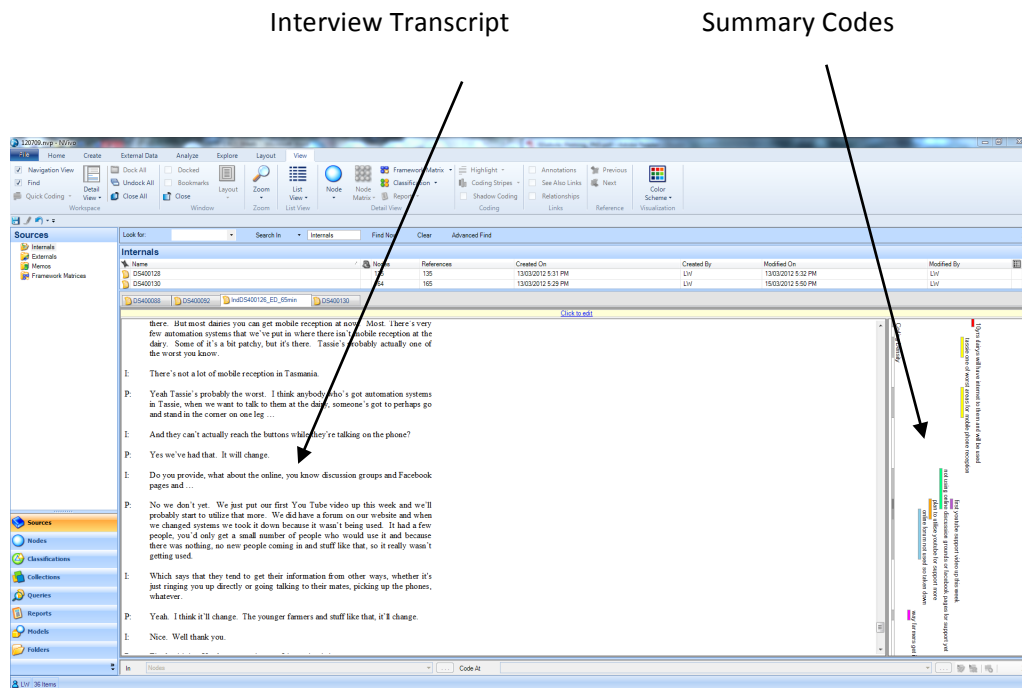


Figure 3-5 Screen shot from NVivo showing coding from the transcripts
Source: NVivo 2012, personal file.

Figure 3-5 shows the summary codes resulting from data reduction for a small section of a transcribed interview. The transcription text is in the middle 'box', and the series of coloured bars on the right hand side indicate visually which part of the interview transcript is coded, and shows the applicable Data Reduction - Summary Code. Table 3-4 shows extracts of the interview transcripts, and process of Data Reduction, producing Summary Codes. These summary codes are represented by the coloured lines and black writing on the right hand side of Figure 3-5.

Interview Transcript	Summary Codes (Data Reduction)
Well, one of the things I think is really good with the robots, you can get people that are just better at managing things, because how many people have got a good education still want to start like four o'clock in the morning or five o'clock in the morning? They say, oh, bugger that. But no, we start like seven o'clock, six, seven o'clock, with calving we do earlier, but otherwise I get up about half past six or something, have a bit of breakfast and a cup of tea and then you go out and check everything, set up the paddock for the day and you're done. So you can get, like these people with better skills,	Robots - attract better managers, better skills as hours better.
I guess down the track if we ever have any trouble with labour or anything like that, it may well be an option for us to go that way,	If staff issue in future robots may be the go
Yea, exactly. In comparing with what my neighbour's got, he's got underground cables, he has another line, so he must have another phone line for his Internet and he's Big Pond for arguments sake and he's forever running out of his allowance which cost him. He's only getting 500mb off peak and 500 on peak, the same as I am and his costs him about \$60 odd dollars and mine costs me \$20!	Compares Internet costs to neighbours
I think if they're used well and the person involved also has a good eye but we've heard some horrific tales about people who really just treat it as a fully automated system and I don't think it can be when you've got young	RCF good if used well & person also had good eye
If you take that up another notch, I would find I can handle it, but I would need to find someone as capable, I am not saying I am a genius, but you would not just be able go and hire anyone if you went to that next level, and put on robots	Robots couldn't just go and hire anyone
I could but I didn't. The screen was too small to see them properly, there's a bigger screen on the iPhone, and something you can read.	Mobile phone screen size limits use for email

Table 3-4 Examples of Data Reduction.

This step was done in NVivo, and then the Summary codes exported to Excel. Source - personal data

STEP TWO – OPEN CODING PRODUCING CONCEPTUAL LABELS

Coding refers to an analytical process in which data is condensed and categorised into a format to assist analysis. A code is attached to a group of words, phrases, or sentences to assign meaning. They provide retrieval and organising of the data, allowing the researcher to spot quickly, pull out, then cluster all the segments relating to particular questions, concepts or themes (Huberman and Miles, 1994). Open coding, as described by Strauss and Corbin (1990), Dey (1999) and Charmaz (2006), is the analytical process through which

concepts are identified and developed and their properties and dimensions are discovered in data. Open coding is the first basic analytical step and results in conceptualising the data (Strauss and Corbin, 1990). The analysis of raw data is required to allow the researcher the ability to discuss or relate information gathered easily (Strauss and Corbin, 1990). The second iteration of open coding produced a large number of conceptual labels. Table 3-5 provides an example of how summary codes were abstracted to conceptual labels. Two iterations were performed to ensure the richness of the data was not lost.

Summary Code	Open Coding	
	Conceptualising	
Younger farmers don't have capital to invest in tech	Young farmers capital limitations	Young farmers capital limitations
RCF good if used well & person also had good eye	RCF needs good stockmanship	RCF staff considerations
RCF - didn't work with weekend staff despite training	RCF staffing problems	
Robots - advertise Australia or world for manager	Robot different skillset	Robot different skillset
If staff issue in future robots may be the go	Future staffing problems	Robot fix staffing problems
Robot farms need to be big to justify someone always being there	Robot staffing issues	Robot labour considerations
Want robots due to staff problems	Robots - staff	Robot labour saving
Robots couldn't just go and hire anyone	Robot requires different staff skill set	Robot new staff skill set
Robots - attract better managers, better skills as hours better.	Robot attract better quality staff	Robot quality staff

Table 3-5 Abstraction of Summary Codes to conceptual labels.

Also grouping of conceptual labels to create Themes by relationships. Source NVivo personal file 2012

STEP THREE – CONCEPTUAL LABELS GROUPED TO PRODUCE THEMES BASED ON RELATIONSHIPS

“At this stage in the analysis, there is less concern for a detailed, precise description of the theme and more concern for recording any glimmer of themes or patterns”. (Boyatzis, 1998 , p. 86)

The second iteration of open coding produced a large number of conceptual labels (step two). The large number of conceptual labels were then abstractly analysed to determine links and relationships between them, with this being the third iteration of the coding process. The outcome was the generation of a number of analytical categories or themes, representing an abstract grouping of concepts (Strauss & Corbin 1990). The researcher achieved this by comparing categories or themes and looking for similarities or differences

to assist further grouping. Once these had been identified then the themes could be rewritten, usually to a higher level of abstraction.

“I examined the list of themes and looked for themes from each list that may be related. They may appear as polar opposites of a characteristic or may merely seem to involve similar phenomena”. (Boyatzis, 1998, p. 87)

Conceptual Label	Theme
Young farmers capital limitations	Changing Future
RCF staff considerations	
Robot different skillset	
Robot fix staffing problems	
Robot labour considerations	
Robot labour saving	
Robot new staff skill set	
Robot quality staff	

Table 3-6 Grouping of Conceptual Labels to produce Themes.
Source NVivo personal file 2012.

Table 3-6 demonstrates how conceptual labels were categorised (themed) by grouping and then assigned an abstract name, such as CHANGING FUTURES. Similar concepts were grouped to form categories (themes) where their properties and dimensions could be examined. The grouping of concepts into themes or categories enabled closer examination of the data and allowed the researcher to question the data with a view to identifying new discoveries (Strauss and Corbin, 1990). A critical aspect to developing an honest and accurate inductive code was the reading and rereading of the data (Boyatzis 1998).

STEP FOUR – CLUSTERING

The final stage of coding involved the grouping of themes into clusters. Forming clusters of themes may be useful as a way to organise the code: that is, to organise the array of themes identified (Coffey and Atkinson, 1996). It may also be useful in the transformation of the data to aid in the analysis, whether descriptive of empirical (Boyatzis, 1998). Clusters of themes may be important for the presentation of the findings (Boyatzis, 1998). Themes may be organised in the context of other themes, as independent clusters of themes, or in a hierarchy (Boyatzis, 1998).

Individuality of the farmers came through strongly in the analysis of the data, and it was important to the researcher not to lose this individuality in the analysis through further abstraction. Themes were grouped into clusters for the final stage of the analysis. This was achieved by the researcher writing the themes down on individual pieces of card and

utilising a visual and physical method, the researcher played with groupings by physically arranging the pieces of card. The researcher arranged the themes cards into groups or 'clusters' by theme concept. Once the researcher was comfortable with the groupings, a photo was taken of the clusters of themes. The process was then repeated to investigate if a less obvious clustering could be developed that fitted the data better. The second attempt provided no meaningful groupings, resulting in the initial group of themes into clusters being used by the researcher.

Theme	Cluster
Hard work; Trust Relationships; Changing Future	LABOUR
Personal Challenge; Support rural communities; conservation; Lifestyle; Generation; Grounding; Family Farm; Technology adopters	THE FARMER
Pasture Management; The Hub; Herd Management;	OPERATIONAL TECHNOLOGY USE
Support; Industry not Leading; Information seeking; Lacking Driver; Convergence;	EXPLORING OPPORTUNITIES

Table 3-7 Example of grouping of themes into Clusters by theme concept.

Source: NVivo personal file 2012

Table 3-7 provides an example of themes grouped into clusters. The cluster LABOUR groups all themes corresponding to labour on the dairy farm. The development of this cluster is illustrated by following the flow of the bolded text through Tables 3-2, 3-3, 3-4 and finally Table 3-5. Specifically, from bolded industry transcript in Table 3-2, data reduction occurs to produce summary codes. These bolded summary codes are transferred to Table 3-3. Table 3-3 demonstrates the abstraction of summary codes through two iterations to produce conceptual labels. These conceptual labels are started with in Table 3-4 that demonstrates grouping of the conceptual labels into themes. Table 3-7 illustrates the theme *Changing Future* being grouped into the cluster LABOUR. Table 3-8 contains a summary of an example of the coding leading to the cluster LABOUR.

The cluster THE FARMER groups all themes with the farmer being central. Following on from this, OPERATIONAL TECHNOLOGY USE relates to the everyday operational running of the farm; and the cluster EXPLORING OPPORTUNITIES groups themes where farmers' behaviour, experiences and interaction with ICT influences their decisions.

Interview Transcript Summary Codes (Data Reduction)		Open coding		Theme	Cluster
		Conceptualising	Conceptual Label		
Well, one of the things I think is really good with the robots, you can get people that are just better at managing things, because how many people have got a good education still want to start like four o'clock in the morning or five o'clock in the morning? They say, oh, bugger that. But no, we start like seven o'clock, six, seven o'clock, with calving we do earlier, but otherwise I get up about half past six or something, have a bit of breakfast and a cup of tea and then you go out and check everything, set up the paddock for the day and you're done. So you can get, like these people with better skills,	Robots - attract better managers, better skills as hours better.	Robot attract better quality staff	Robot quality staff	Changing Future	Labour
I guess down the track if we ever have any trouble with labour or anything like that, it may well be an option for us to go that way,	If staff issue in future robots may be the go	Future staffing problems	Robot fix staffing problems		
I think if they're used well and the person involved also has a good eye but we've heard some horrific tales about people who really just treat it as a fully automated system and I don't think it can be when you've got young	RCF good if used well & person also had good eye	RCF needs good stockmanship	RCF staff considerations		
If you take that up another notch, I would find I can handle it, but I would need to find someone as capable, I am not saying I am a genius, but you would not just be able to go and hire anyone if you went to that next level, and put on robots	Robots couldn't just go and hire anyone	Robot requires different staff skill set	Robot new staff skill set		
				Trust relationships	
				Hard work	

Table 3-8 Summary of LABOUR Cluster

In the analysis chapters (Chapter 4 and 5) the individual themes are analysed within their clusters. Individual farmer and industry quotes are used to illustrate points. To maintain the anonymity of farmer and industry representatives in analysis and interpretation farmers and industry representatives quotes are identified by numbers or letters, and names are changed if individuals are mentioned, and names of private companies removed.

This section has presented the data analysis method adopted for the dual lens data collection. The data analysis supported the research strategy (section 3.4) the research design (section 3.5) and the tools and techniques (section 3.6) chosen in this research.

3.8 TRUSTWORTHINESS AND RESEARCHER BIAS

Qualitative research is subjective in nature (Denzin and Lincoln, 2005) and hence vulnerable to bias from the researcher. Rather than objectivity, the focus should be on fairness where all possible attempts have been made to have all voices in the inquiry treated fairly and

with balance (Guba and Lincoln, 2005). However qualitative research needs to be evaluated using appropriate criteria. Lincoln and Guba (1985), proposed four criteria that they believed should be considered by qualitative researchers in pursuing a trustworthy study. These were credibility, transferability, dependability and confirmability. These were further qualified by Shenton (2004), and each of these will now be addressed below.

The credibility of this research is provided in the research design. Lincoln and Guba (1985), refer to the researcher having an extended time in the field with persistent observations to ensure credibility. The design of this research (see 3.5) was based on the researcher interviewing a number of dairy farmers to capture the diversification and uniqueness of farmers as individuals. Data saturation or theoretical saturation is integral to naturalistic inquiry (Glaser and Strauss, 1967; Strauss and Corbin, 1998). Data saturation entails bringing in new participants into the study until the data set is complete, as indicated by data replication or redundancy. Theoretical saturation is the point at which no new insights are obtained, no new themes are identified, and no issues arise regarding a category of data (Strauss and Corbin, 1990). The researcher interviewed new farmers to the point of diminishing returns where nothing new was being added through new farmer interviews. In addition, qualitative research may involve the researcher using their own experience to bring out the meaning of the data (Strauss and Corbin, 1998). Therefore to address possible researcher bias and ensure credibility the rich description produced from farmer interviews was provided with an alternative lens of Industry interviews. This alternative lens provided triangulation and 'may well prove invaluable in order to check that supplied by the users, to help explain their attitudes and behaviour and to enhance the contextual data relating to the fieldwork sites' (Shenton, 2004 p. 66). Triangulation is used to refer to the observation of the research issue from (at least) two different points. Triangulation of data combines data drawn from different sources and at different times, in different places or from different people. (Jupp, 2006 p. 306). Tactics to help ensure honesty in informants and hence promote confidence that the phenomena has been accurately recorded under scrutiny (Shenton, 2004) were employed, including each person approached was given the opportunity to refuse to participate, and participants were encouraged to be frank from the outset of the interview by the researcher building a rapport at the beginning of the interview and indicating that there were no right answers to the questions that were to be asked.

The transferability of this research is in the hands of the reader (Bradley, 1993). Every effort has been made to provide the thick description necessary to enable the reader to make a decision as to whether transferability is a possibility (Lincoln and Guba, 1985) by conveying to the reader the boundaries of the study as described by Shenton (2004), being:

1. The number of organisations taking part in the study and where they were based;
2. Any restrictions in the type of people who contributed data;
3. The number of participants involved in the fieldwork;
4. The data collection methods that were employed;
5. The number and length of the data collection sessions;
6. The time period over which the data was collected.

However since the researcher knows only the “sending context” or environment this research is conducted in, she cannot make transferability inferences (Shenton, 2004 p.70). The research design has provided the reader with two alternative lenses – farmer and industry.

The dependability of this research is provided through the clear and detailed methodology. Shenton (2004), recommended so as to enable the reader to develop a thorough understanding of the methods and their effectiveness that the methodology include:

1. The research design and its implementation, describing what was planned and executed on a strategic level;
2. The operational detail of data gathering, addressing the minutiae of what was done in the field;
3. Reflective appraisal of the project, evaluation the effectiveness of the process of inquiry undertaken.

While objectivity in science can be obtained with the use of instruments that are not dependent on human skill and perception, qualitative research by nature makes the intrusion of the researcher’s biases inevitable (Patton, 2002). The concept of confirmability is the qualitative investigator’s comparable concern to objectivity, referring to the degree to which the results can be confirmed or corroborated by others. Farmers and Industry have provided the confirmability of this research. The thesis provides a rich description of the industry and its practices. This information is presented to provide the reader with a clear understanding of the characteristics of the data and the research results. A number of steps were taken to reduce the impact of bias on the collection and analysis of the data.

Data was collected using the formal approach of semi-structured interviews. Each of the interviews was digitally recorded to ensure accuracy. The researcher transcribed the recordings accurately. The data was analysed using a rigorous data analysis technique (see section 3.7.1) and every effort was made to ensure that the overall approach was transparent (Auerbach and Silverstein, 2003). Farmer and industry interviews were treated independently to provide an alternative lens. The resulting themes from industry and Farmer interviews are grounded in the data. Ajzen (1991), considers that a key criterion for confirmability is the extent to which the researcher admits his or her own predispositions. The researcher has worked in the Dairy Industry in Australia for ten years in a commercial context as well as in an industry and government funded research capacity. Due to the researcher's extensive industry knowledge, and hence the opportunity for the researcher to introduce bias into the research, a rigorous grounded data analysis approach was followed carefully to restrict inadvertent researcher bias. The researcher's industry knowledge was utilised in the findings and discussion chapters to enhance discussion and to 'place' the research in an industry context.

This section addressed trustworthiness and the treatment of researcher bias. The next section will present information on how the outcomes from the data analysis are presented in subsequent chapters.

3.9 DISCUSSION AND INTERPRETATION

The researcher provided an integrated interpretation of the data analysis of Chapter 4 (farmer) and Chapter 5 (industry) based on the themes that emerged. The researchers' interpretation of the data was based on the insights which she had obtained from being deeply immersed in the field, and utilised field notes, observations, and documentation collected.

Key findings emerged through this process and are discussed in Chapter 7.

3.10 MODEL DEVELOPMENT

From the review of ICT adoption literature in section 2.5 two models, UTAUT and TAM3 were considered as potentially suitable to be used as a theoretical lens in this research. The model UTAUT was discounted due to the concern it would provide little theoretical insight to explain the reasons behind the adoption of ICT by family farming businesses. This is supported by Bagozzi (2007) who criticised that moderators are demographic variables,

providing little theoretical insight to explain ‘the why’ behind proposed interaction effects, with this model having at least 41 independent variables. Based on this TAM3 was selected as being the most appropriate theoretical lens to apply. TAM was developed specifically to predict individual adoption and use of new information technologies. Recently, Venkatesh and Bala (2008) introduced an integrated model of TAM (TAM3) by combining TAM2 and the determinants of Perceived Ease of Use proposed by Viswanath (2000). TAM3 presents the most comprehensive version of TAM to date. TAM3 presents a complete nomological network of the determinants of individuals’ ICT adoption and use, with the strength being in the comprehensiveness and potential for actionable guidance.

A revised TAM3 model was developed based on the findings of the research conducted in this thesis. This revised model being presented and discussed in Chapter 7, section 7.3.

3.11 CHAPTER REFLECTIONS

This chapter has discussed the research philosophy and has stated the ontology and epistemology adopted in this thesis. A subjective ontology utilising an interpretive epistemology was deemed to be the most appropriate for this exploratory research.

The application of a case study strategy using 33 individual farmers was employed to acquire a rich data source from a broad range of farmers located in Tasmania, and six industry representatives servicing Tasmania.

This chapter has discussed the research design and methods used to collect the data. A series of interviews was conducted with owners of family farm businesses and appropriate industry using semi-structured in-depth interviews. The questions were designed to gather the farmers’ opinions, experiences and how they used ICT for business and personally, the impacts and problems associated with the use of ICT and background information about their business. Industry interviews were conducted to provide an alternative lens in recognition that external factors, some of which farmers may not be aware of, are important. This provides an alternative perspective for the research.

After transcription, the interviews were analysed systematically using thematic coding with the inclusion of open coding. The farmer and industry interviews were analysed separately but using the same methodology. This approach ensured any new industry insights in the Tasmanian dairy industry were revealed. A visual summary of the 32 farmer themes

grouped into five clusters is presented in Figure 3-6, and the 27 industry themes grouped into five clusters are presented visually in Figure 3-7.

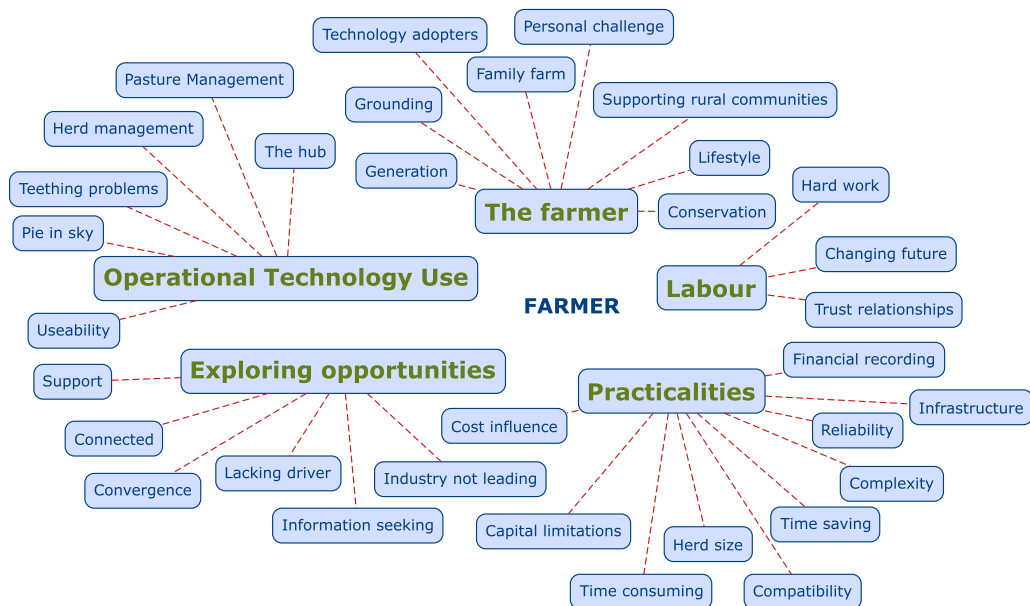


Figure 3-6 Summary of 32 farmer themes grouped into five clusters.

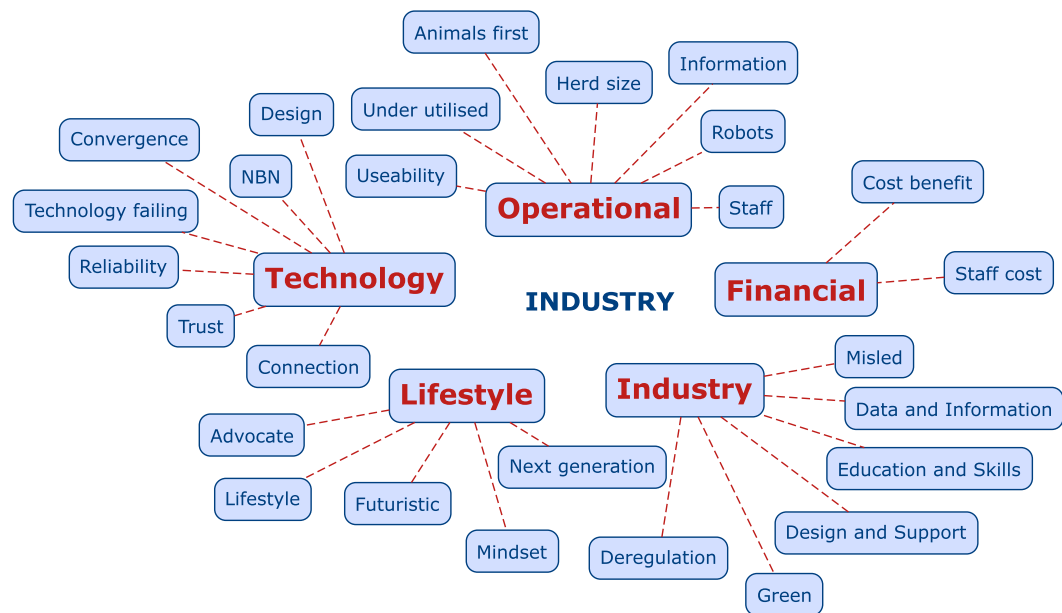


Figure 3-7 Summary of the 27 industry themes grouped into five clusters.

The next section of this chapter examines the process used to interpret and discuss the research. Chapter 6 distils the themes from Chapters 4 and 5 into eight overarching preliminary findings and discusses these in relation to the available literature. Chapter 7 presents the key findings that emerged from interpreting and discussing the data in Chapter 6. These key findings are further interpreted and discussed in relation to the available literature.

The last section in this chapter discussed the selection of TAM3 as a basis of a theoretical lens for the research conducted in this thesis. This model in a revised form is presented in Chapter 7, section 7.3.

The next chapter presents the data analysis of the 33 farmer interviews using thematic analysis.

FARMER PERSPECTIVES ON ICT USE

4.1 INTRODUCTION

This chapter is the first of two analysis chapters and provides an analysis of the data from 33 semi-structured interviews with Tasmanian dairy farmers operating as family farm businesses (demographics described in Table 3-1 and Table 3-2). The next chapter (Chapter 5) will provide an analysis of the data from six separate industry interviews.

This chapter presents the themes produced as a result of the coding process conducted on interviews of Tasmanian dairy farmers. The 32 themes are grouped into five clusters in no particular order. Extracts from the interviews are provided to demonstrate the development of each theme:

- Section 4.2 provides a detailed description of the themes grouped under the cluster OPERATIONAL TECHNOLOGY USE. These themes relate to the everyday operational running of the farm. The themes discussed are PASTURE MANAGEMENT, THE HUB, HERD MANAGEMENT, TEETHING PROBLEMS, USEABILITY and PIE IN SKY. PIE IN THE SKY represents farmers' visions for the future and how they see the management of the farm changing in the future with the use of ICT.
- Section 4.3 provides a detailed description of the themes grouped under the cluster THE FARMER. These are themes where the farmer is the central focus. The themes discussed are PERSONAL CHALLENGE, SUPPORTING RURAL COMMUNITIES, CONSERVATION, LIFESTYLE, GENERATION, GROUNDING, FAMILY FARM and TECHNOLOGY ADOPTERS. The theme GENERATION describes how different farming generations may have divergent life and work priorities and expectations, and the theme GROUNDING captures the farmers' relationship with their cows and the land.
- Section 4.4 provides a detailed description of the themes grouped within the cluster LABOUR. These themes relate to the labour required on a dairy farm. The themes discussed are HARD WORK, TRUST RELATIONSHIPS and CHANGING FUTURE.

- Section 4.5 provides a detailed description of the themes grouped within the cluster PRACTICALITIES. These themes describe the practicalities of human–ICT interaction. The themes discussed are INFRASTRUCTURE, RELIABILITY, COMPLEXITY, COMPATIBILITY, COST INFLUENCE, TIME CONSUMING, HERD SIZE, CAPITAL LIMITATIONS, TIME SAVING and FINANCIAL RECORDING.
- Section 4.6 provides a detailed description of the themes grouped within the cluster EXPLORING OPPORTUNITIES. These themes express the farmers’ exploring of opportunities, and how these experiences influence farmers in the decisions that they make around the farm. The themes discussed are SUPPORT, INDUSTRY NOT LEADING, INFORMATION SEEKING, LACKING DRIVER, CONVERGENCE and CONNECTED.
- Section 4.7 provides a summary reflection of the chapter.

4.2 OPERATIONAL TECHNOLOGY USE

This cluster represents the themes that relate to the everyday operational running of the farm. PASTURE MANAGEMENT encompasses everything to do with pasture, pasture measurement, pasture management software, and soil moisture monitoring. Pasture is the main feed component of dairy cow diets on Australian dairy farms and therefore an integral part of the farm system. THE HUB symbolises the milking shed, which is where the cow, human, and ICT interaction currently predominately occurs.

The milking shed is the largest capital investment on a dairy farm, and traditionally requires the largest labour investment on a daily basis with all milking dairy cows passing through this structure twice a day under conventional systems. It is the milking shed where the majority of information about the cows is collected and acted on, such as milk production, mastitis levels, and reproductive management. HERD MANAGEMENT captures the farmer’s interaction with herd management software, which may link into or be the same as the system run in the milking shed, or entirely separate. Key factors are how the information is entered in the software (for example whether there is automated entry of information or whether key data is entered manually), and how and what the software is used for, and what value is placed on the resulting information. TEETHING PROBLEMS covers problems with the implementation of new ICT. These problems include specific robot implementation problems, general ICT technical issues, and include practical problems such as the time of putting a new ICT system in, and the stress associated with installing and implementing a new system. USEABILITY encompasses the usability of systems, including

the reputation of a system to be useable, and how easy a system is to interact with. PIE IN THE SKY represents farmers' visions for the future, and how they see the management of the farm changing in the future with the use of ICT. This includes thought processes such as 'I wish we could do this' and 'I can see us being able to do this in the future'.

4.2.1 Pasture management

The theme PASTURE MANAGEMENT explores ICT use in the growing and management of pasture on the farm. Irrigation systems such as linear and centre pivots may be computer controlled, which saves significant time, and reduces the need to be physically on the farm. Irrigation that is moved manually benefits from GPS devices that show exactly where the irrigation can be placed. This means the job can be shared around and does not have to be done by one person, which is often the owner in order to ensure that the job is done right.

Irrigation is often used to supplement pasture growth. The most time and water efficient irrigation systems, Linear Moves and Centre Pivots, may be linked to moisture meters and controlled via mobile phone, enabling knowledge and control of the irrigator without having to be on the farm.

...I wanted to be able to start and stop it (irrigator) and know what it was doing if I wasn't here... [FARMER 8]

So basically James spent his whole life chasing travelling irrigators and everything else, where he had to look at them all the time and see if they were walking down the paddock. We're in an era now of centre pivots with technology, so basically I can set that machine up before I go, before I go home, and I don't worry about it. Because I know they will only get to a pre-set point tonight. [FARMER 20]

Future proofing irrigation system control panels is also important. This also allows additional ICT to be added as it becomes available and as the budget allows without having to replace irrigators. The farmer below demonstrates this thought.

...I've got the [control] panel that I can connect to in the future and I can link up. [FARMER 20]

Getting the correct consistent positioning of movable irrigation systems is essential for water efficiency to avoid overlapping or missing of watering areas. GPS devices are being used to map irrigation moves so any staff member can do this job, otherwise it is often the

owner who must attend to this personally. During the summer, the time it takes to irrigate can be substantial, meaning the requirement on one person's time can be significant.

...six and a half grand, but it was a no brainer in the end just to be able to have anyone go and put the sprinkler in and know where it's got to go. Makes life a lot more flexible. [FARMER 6]

Pasture management of Robot systems (AMS's or 'Robots') is very different to traditional milking methods. Traditionally cows are physically 'rounded up' twice a day and walked to the milking shed and milked. With robotic milking, cows independently make their way to the shed over a 24-hour period, a few at a time. To encourage this independent movement, cows are encouraged to and from the shed using the enticement of food. The cows are given access to fresh pasture after being milked by being directed to a different paddock. Farmers' lack of confidence in their ability to manage pasture to enable this was expressed.

...I think you have to be such a fantastic pasture management manager to make those robots work, because they are so driven by the feed aren't they? ...so I think you would have to be really switched on [at managing pasture], which we try to be, but... [FARMER 15]

4.2.2 The hub

The theme THE HUB relates to everything to do with the 'milking shed', 'shed', or 'dairy', which are terms that are used interchangeably.

'The Hub' is where the traditional relationship between cow, human, and ICT occurs. With the evolution of robotic milkers, this relationship is changing, in that the human component of this interaction does not have to be predominately in the shed but may alternatively be in the paddock as the robot takes over the physical milking of the cows and the human is not required.

Upgrading the shed is cheaper than building a new one, and is the preferred option because this is cheaper, however physical limitations may require the building of a new shed. If this is the case, investment (and hence implementation of ICT systems) may be delayed. This effectively means a farm may go from a very basic system to being fully automated without any middle ground. It is not that the farmer of this basic system is not interested, or does not value the benefits of ICT with ICT advantages well recognised by the farmer, but rather they cannot be justified. Farmers' may hold off investing in a new shed,

preferring to wait for robotic rotary sheds to progress from the trial stage to commercial application (the first commercial robotic rotary in the world was installed into a Tasmanian dairy farm in January 2012). The proximity of this to the farmers studied made this a topic that every farmer interviewed had thought about.

Our sheds got sort of another 15 years left in it so we're not spending any money changing the dairy. Probably within 10 years, financially we won't be in a position to change the dairy and to change the dairy you'd go to the robots, a proven one but they need to get an automated rotary robot set up [next shed upgrade considered to be a robotic rotary, farmer is waiting for industry to develop robots commercially capable in a rotary environment] and that would be the next step for here I guess. But that's 10 to 15 years away. [FARMER 6]

The benefits of ICT in the shed are recognised by farmers who do not have not yet installed any ICT in the shed, as demonstrated by the quote below, which is provided by a stud breeder of a family farm that has been in the family for generations. This farm has another large block recently purchased, and the next step shed investment wise will be a new dairy on this larger new block while retaining the traditional family block for young/dry stock.

I think it [technology] will become increasingly important, I think that the farms that do have the technology with the big neck collars around the cows, and then they are scanned and you can immediately see what their milk production is, and if they have got a problem, and heat detection - I think it is all really, really wonderful... [FARMER 28]

ICT may be in the shed without the farmer having interaction with it during the milking, such as when cows are fed an individually tailored ration. The cow is recognised using the Radio Frequency Identification (RFID) or 'electronic ID tag' in its ear, and fed an individualised amount of ration that is pre-set by the farmer.

Well the computer reads their ear tag. They've all got ear tags and that gets read to feed them, [FARMER 12]

Use of an integrated herd management system in the milking shed incorporating electronic identification provides a backup to cover human error due to weather, inexperience or any other external factors, preventing situations such as the situation in the quote below, where a vat of milk was lost due to cups being put on a cow that should not have had her milk go into the vat. This farmer has since put in a system to prevent this happening in the future.

... always a worry, we have lost one vat load of milk with a treated cow going in there [the vat]. We painted her and it was a real stormy night and they stood with their backs to the wind the whole night and it washed the paint off her, we had an inexperienced milker in there, I was with him, but we got to the end of milking and this cow wasn't there. We lost a full vat of milk. [FARMER 15]

4.2.3 Herd management

The theme HERD MANAGEMENT relates specifically to herd management software where predominantly the cows calving, mating, milk production data and health records are collated and interpreted. THE HUB and HERD MANAGEMENT on some farms are closely linked, with the herd management software running the shed as well, and information collected from the shed going directly into herd management systems. With more farms having HERD MANAGEMENT systems than the integrated THE HUB setup, separating out the two was required.

The herd management software used, and how this is integrated into THE HUB differs between farmers. At the basic level, if the farmer just wants to be able to search and find cows, and order cows based on information such as drying off date or heifer details they may choose to manually enter information into a spread sheet such as Excel because the data entry is simple and familiar.

... if I am inputting data, it is pretty easy just to input into Excel. It puts it all into order [FARMER 25]

Other farmers, recognising that information recording is important, see herd management programs as a way of assisting with this. The family farm below has 800 cows, and five additional staff, and has been focusing until now on a recently completed centre pivot infrastructure, but recognises that improved data management is now required.

...We need to refine our information data recording I think, with our Farm Keeper and that sort of thing [FARMER 6]

If the farmer does not have milk meters in the shed, the industry offers a user-pay service, where the farmer can pay to have milk volumes and the somatic cell count (a check for mastitis) measured for each milking cow in the herd. Data may come back from herd tests electronically and be loaded back into farmer herd management software or as reports by e-mail, or herd test results may come back in hardcopy. Some farmers find the paper

records more convenient as they can be looked at not just when they are in front of the computer, whereas other farmers find the speed electronic results integrate back into their herd management package to be of advantage.

... It used to come onto the computer, but it wasn't suitable, so he [husband] stopped that, he just gets his [paper] reports now... [FARMER 28]

... After each herd recording straight away I want to know if there are any high cell count cows ... I can do that before I get the hard copy... [FARMER 4]

Herd management programs are perceived to be easier to manage information with than a book system with important details being easier to find on the computer.

... I think it would be easier to manage rather than having to find which book did I write this in. [FARMER 16]

The farmer below recently put in a brand new fully automated Rotary, which therefore comes with its own integrated herd management system. In this case, the farmer is willing to persevere, and learn as time permits.

... that is what you do, you just go and tinker... I like doing it. If I've got the time to do it, it is good, if I want something to work and I'm under the pump and I wanted it to work yesterday, then I will get on the phone, but when I am not under time pressure, then I will just, yes 'knockabout' – 'oh', what does this do." [FARMER 30]

Herd management systems can make life much easier.

...as soon as I find out what day they [Classifiers] are coming, I just enter every heifer into the computer to be drafted out on the day and it doesn't really matter if you forget about it. [FARMER 15]

Herd Management systems are considered helpful to the business as a whole both on a farm management level, and a regulatory licence basis.

...It helps us immensely because if we input all the cow information we then can get reports back... Or let me know when a cow can go back into the vat... Because we have a licence for our dairy, we need to keep records like that. It's all done for us. [FARMER 3]

And also creates an interest in the herd, and is valued.

... I think it tends to create interest in the herd. If you've got your information there, I tend to come home, sit down and think about it, and look for trends. I make a lot of decisions depending on that information.
[FARMER 3]

Herd Management systems may be assumed to be integrated with the milking plant and so a particular herd management package may be used, even if another package is thought to be better.

I used MISTRO before I got the DeLaval system, and it looked fairly good to me... If I didn't have the DeLaval system, something like that would be good because it has got all my cows on it plus all the grass and paddocks and stuff, whereas the DeLaval one doesn't have that. [FARMER 30]

If herd management software is not bundled with the milking machines, Herd Test Centres have an input into software used.

... The herd test centre more or less said WinFarm is out of date, and we're using this (MISTRO) now. [FARMER 7]

4.2.4 Teething problems

The theme TEETHING PROBLEMS relates to problems with ICT implementation. It relates to the practicalities of getting a system working that may have not been considered initially. Systems need to perform the functions promised, and installing a system that works from day one, assists the system to be quickly utilised, and keeps the implementation momentum going.

Systems may be bought in anticipation of features which are promised by the salesman, but do not actually eventuate. An example of farmer expectations not being met is demonstrated by the quote below.

... We could have gotten a simpler manual flow meter, but were planning on these milk meters being able to do conductivity, ... which hasn't eventuated of-course. [FARMER 1]

A loss of momentum to implement technology can be a problem. The farmer below bought a group of moisture meters, tested them upon arrival to find a couple didn't work. Now,

although they are back from being fixed, the momentum has been lost, and the family members cannot agree on where to put the moisture meters.

Tested them [moisture meters], and a couple weren't working....I think if they'd been ready to go the first week he [the son] would have got out there and done it... [now] I think it just comes down to prioritising. They [father and son] had a discussion and couldn't agree – family farms – [consensus difficult on family farms sometimes] on where to put them. [FARMER 17]

Anticipated support and service agents may pull out during the implementation stage of investment. Because Tasmania is so small, a lot of servicing is contracted out, and there is little alternative backup support. In the below case, the farmer thought they had chosen a system with a reliable service agent, but did not know that this company was pulling out of dairy servicing in the region.

... We weren't really aware that that was going to be a problem... We should have had it right at the end of the first year... the company [initial support company] had sort of given up by then. [FARMER 10]

'Teething problems' may continue to the point that the farmer requests the system be replaced. In the below case, it was the electronic cow ID system, which the whole shed relies on.

... It didn't work, and after two years I made them pull it out and completely replace it... [FARMER 20]

If a system has recently been put in close to the most stressful and busy time on the farm (calving), it becomes vital that any teething problems are identified and fixed promptly, with phone support being the quickest way to achieve this.

[The farmer installed a new electronic ID and herd management system into a new rotary dairy which was operational for the first time after the cows had started calving] During calving I just didn't have the headspace to think about things, so I had to make a few phone calls then about how to initially get around [the software and the problems]... [FARMER 30]

Sometimes extra labour needs to be employed to get the new computerised shed up and running. In the case below, the installation of Robots required extra staff to be hired because the 'Teething problems' stage continued for longer than current staff could realistically maintain the additional workload.

Having so much trouble with robots, we employed two more staff to help.
[FARMER 31]

Computer systems need to be working before it is possible to learn how to work them. In the case of this farm, the electronics in the shed (which measure and record individual milk production, mastitis indicators, individualised cow feeding, and other herd management options) were not operational for over 12 months after the initial installation. This meant while the cows could physically be milked, it was impossible to use the software to learn how to use it.

Once it's going you can learn from it, but before it wasn't [FARMER 10]

4.2.5 Useability

The theme USEABILITY encompasses how easy the ICT is to use, and whether this is a consideration factor choosing a system. A system being user friendly is a reason to purchase, and a system may be changed solely on usability. An easy to use system additionally encourages use.

Useability of a herd management program influences what it is used for and how much it is used. Changing to a new program may be considered if an old program is not being used to capacity due to it not being easy to use.

... I haven't been using the WinFarm program probably to its capacity, and it was a little tricky to get around. I haven't been using that technology as much as we could and so we'll probably look at going to this new program (MISTRO). [FARMER 1]

The ease of use of a system can be a reason to purchase in its own right.

...went for this one because it seemed a lot more user friendly, which has turned out to be right... [FARMER 15]

If a herd management system is not seen to be easily adaptable to the farmers' way of doing things, it will not be used even if it has been purchased.

I didn't want to change all the [cow] numbers just to suit a computer program. I wanted it to suit my system, make it easy. [FARMER 25]

With some herd management systems, unless all the required cow information is entered into the system, the system does not produce reports that can be used to manage the herd, as observed in the quote below.

With the ALPRO system, if you don't put everything in, it gives you nothing.
[FARMER 20]

Familiarity with one herd management system can assist transition into a new system. WinFarm is an older system used historically extensively in Tasmania that is not being developed further, so farmers have to switch to other herd management systems. This is being partly encouraged by the herd test centres, and partly because it is not compatible with Windows 7 when farmers upgrade their computers. Some farmers find changing to a new system easy as they can apply the principals from their old system.

... I just worked it out. Because I've had WinFarm, you've got a vague idea of what you're looking for. It's probably just another way of going about getting it and that was really easy. [FARMER 4]

Other farmers find going to a new system can be complex because they are used to a simple system and the extra features are confusing.

... [x herd management system] is a bit confusing. But that's probably because there's so much in it. We used to use WinFarm, which was a very basic one, so going from that to this takes a bit. [FARMER 7]

4.2.6 Pie in sky

The theme PIE IN SKY represents farmers' visions for the future using ICT – both on the farm and with their personal use. The driver for these 'visions is often a view of an easier life with less manual labour. Other ICT upgrades such as better Internet to support this also feature.

...I might have cameras all over the farm, and I might need the NBN (National Broadband Network), the old satellite might not stand up to that...
[Farmer 23]

ICT is changing the way all farmers are thinking about managing their farm, and their future farm. In the comment below, the farmer is considering how ICT can decrease the labour

requirements on a robotic dairy farm through centralised monitoring of more than one robotic farm.

What I see happening is, you know you have a security system, a bloke sits in a room and when the building's getting robbed, the alarm goes off doesn't it, and it goes back to the security centre, and that security centre sends one of his men to check it and rings the person responsible. Well that's the way the system we're putting in should be in 20 dairies about the place, and one bloke should be sitting and monitoring everything else that's going on, and it's all monitored here. [FARMER 20 – FULLY AUTOMATED ROTARY SHED]

4.3 THE FARMER

The farmer is central to themes in this cluster. PERSONAL CHALLENGE presents the concept that standard farming is not enough for some farmers; they need the next challenge. For some farmers this challenge is required to maintain their interest in the farm; for others it is so they have time for personal challenge off-farm. SUPPORTING RURAL COMMUNITIES captures farmers' need to prioritise the support of local rural communities and businesses, and how conscious decisions are made to support this belief. CONSERVATION encapsulates farmers' considerations that conservation is of importance, and the need to identify with nature. LIFESTYLE describes the integrated work, life, and family balance. Because work, the farm, can easily be a 24 hour-a-day, seven day-a-week job, the ability to get out and have a life holds special significance. GENERATION describes that different farming generations may have divergent life and work priorities and expectations. GROUNDING captures the farmers' relationship with their cows and the land. This includes the need to see nature and the farm, rather than rely on technology. FAMILY FARM encapsulates that decision-making may involve multiple generations, all with different comfort levels with technology, and investment priorities, emphasising the family farm as being a unique business entity. TECHNOLOGY ADOPTERS captures individuals' positive attitudes to technology.

The following provides a detailed description of the themes grouped in the above Cluster.

4.3.1 Personal challenge

The theme PERSONAL CHALLENGE describes how ICT has maintained farmers' interest in farming. This is either through increased challenge on-farm using ICT, or through engaging in ICT on-farm which gives them time to pursue off-farm challenges.

ICT has assisted in maintaining personal interest and challenge in the farm for the below family farm where parents and son are all actively involved in the running and decision-making of the farm. This particular comment discusses the fathers approach to technology.

...[husband] has always looked at the economics and he also looks at it from maintaining his interest and his passion in managing change and doing things differently and trying a new system and often a natural system focus but he will incorporate technology into it... [FARMER 17]

There is also the interest in designing robotic system setups for other farmers. This is from the perspective of another farmer using robotics, with the topic arising over a discussion of how farmers know better than the robot manufacturers how cows flow, and what works practically on the farm in a grazing robot system.

... It would be really interesting if I could spend a bit more time and design that [another farmer's robot setup] ... [FARMER 29]

4.3.2 Supporting rural communities

The theme SUPPORTING RURAL COMMUNITIES encapsulates the farmers' identity and support for their community and local businesses while also helping each other out. This identity also extends to the state level 'Tasmania'. The practical implication of rural community shops closing is the option of business over the Internet or a longer drive into a larger town.

There is a preference to support local businesses if the local businesses reciprocate with good service.

... I don't like big companies, I like to try and support the locals. I buy as much as I can down here, close – if I get good service it is more important than trying to save money... [FARMER 25]

A Tasmanian farmer's definition of a local community to support may be at the local or state level.

...I won't sell cows to the mainland, because Company X were just buying the choppers, putting them on the boat and sending them all the way up to northern Victoria. We have an abattoir here. [FARMER 13]

The closing of local small town shops has also forced the choice of using the Internet for purchase, or driving further to a larger town.

... I was about to [buy things online]. I have some photos that need developing, and all of the photo shops have shut in Ulverstone... [FARMER 25]

Rural communities help each other out when needed. This farming family moved from Victoria to Tasmania with all the cows, with the son coming down first with the rest of the family to follow, meaning the son was by himself on the farm.

...he'd been here two weeks on the farm and he still didn't have milkers and they were arriving first thing in the morning and hadn't been milked for 24 hours, missed a milking. So funny enough, he called in to get petrol that evening before they arrived at the local petrol station in town where he'd befriended the owners there and he must have looked a bit down in the dumps and Joe said, "how are you going out there young fella", because he knew he was out here on his own although the neighbours have been terrific. And Tom said, "yea I'm just trying to figure out how I'm going to milk 150 cows on my own in a rotary that have never been in a rotary before because we had herring bones at home" and Joe, who's not a dairy farmer said, "ok, wait here, I'll get on the blower" and within 15 minutes he had about half a dozen people organised... [FARMER 17]

4.3.3 Conservation

The theme CONSERVATION captures how farmers' value and identify with the natural environment. This identification with the land influences the farmers' attitude to ICT, with the use of ICT coming second to the perceived priorities of the natural environment. The natural system is important, and takes priority, as it needs to be looked after for future generations. This belief links through from the land to the larger environment, with considerations such as the use of alternative energy sources. These environmental investment priorities are tempered by the perceived financial implications.

There needs to be a balance between nature, practical knowledge and technology needs.

[420 cow cross-breed farm – 50 bail rotary shed] That's coming back to that respect for technology which is linked to research and information and new ideas. I don't think we should stop valuing and stop doing our involvement with the natural systems and the observation and the practical stuff. [FARMER 17]

Farmers consider themselves land custodians for future generations, and manage the properties sustainably.

[50 cow farmer of Ayrshire breed 6 aside herringbone] *Because the land is here for aeons, we're only transitory - humans only come for a few decades and they're gone, so we should look at the land as a long term thing and this is where the land care comes in – the land should be better when we leave it than when we come here...* [FARMER 14]

The same farmer went on to explain that sustainable farming should be the first priority, with technology only being used if sustainability can be achieved. The definition of sustainability is broad reaching and includes social interaction.

We're low cost, simple, we don't irrigate, we try and work with nature rather than against it.... I think if we're going to have a technological future we going to have to have a sustainable future and a future where we still interact with each other. [FARMER 14]

Alternative energy sources are of interest for the environment, and may be financial beneficial to family farm businesses due to continuously increasing power costs. The time taken to recoup in cost savings the upfront costs associated with installation of alternative energy sources such as solar are taken into consideration.

[830 cow Jersey cross herd - interested in solar power investment] *Environmentally because we are power hungry, and cost... I'm not sure the pay back is making it worthwhile.* [FARMER 6]

4.3.4 Lifestyle

The theme LIFESTYLE represents the importance of lifestyle in the decision-making process. Dairying is recognised to be profitable, but very time demanding. ICT is considered to be a way to maintain contact with the farm while not being there (such as holidays) through remote monitoring, a way increase the flexibility of when those hours are worked, and to also reduce the dependence on individuals by creating tasks that can be done by different people. The benefit of this is fewer requirements by the owners to milk (not generally a loved task), and increased family and personal time. The ability of ICT to operate in the background particularly during milking reduces the stress of milking for both the owner and the milker. Robotics improve the relationship between the cows and the family members leading to the cows being easier to work with and the family being involved more with the cows due to the cows improved temperament.

Although dairying is considered to be very labour intensive, it also is considered the only way to service a large agricultural debt. The rate of return on a dairy farm enterprise is significantly higher than on an alternative enterprise such as beef or sheep farming.

Milking is the only way one can service the large debt. [FARMER 2]

The lifestyle benefits of living in a particular location may take priority over what may be considered to be a better location to maximise farm profit.

[Four young kids; only a one hour drive to Hobart] ...being here, it is a good location. I think if I was really serious about being a top-notch dairy farmer, I probably would have sold this place and moved somewhere else. [FARMER 30]

Farming can be a 24/7 job, particularly if there are no staff to share the workload. The stock work on this 220 cow farm is done by the father, and son who has just come back onto the farm, with a weekend milker. The father is ready to retire as soon as the son can take over. The parents have never taken a holiday, and the father does not really trust others with the cows. The son is looking at ways to change the way the farm operates.

[father] ... It's a 24 hour job nearly, like you could be here at ten o'clock, I think the other night ten o'clock or something and you know the cows start singing out and they're out, they're away. It means you've always got to be here... [FARMER 21]

There is motivation for future ICT use if the farmer does not want to have to do a job by himself or herself all the time in the future.

... [Sprinkler moves using a GPS to plot the position of the moves] ...that would save time, it would mean more than one person can do it, ...if I don't want to do it any more, those GPS's would be good. [FARMER 25]

A laptop means the farmer can see what is going on, on the farm without having to be there.

Yes, and I can access, do whatever I need to do, wherever I am. If we go away on holiday, the laptop usually comes with us... [FARMER 28]

Use of some ICT means the farmer can go on holiday with the family, yet still monitor automation equipment, such as irrigator controls.

...got a place down at Port Sorell so we want to be able to utilise that a bit more, so I can be down there with the kids and start the irrigator. [FARMER 16]

Diversification of the business aims to value-add to the milk, and present additional marketing opportunities.

And the other thing we will be doing is, we've been using A2 bulls [A2 is a type of protein produced by some dairy cows which can be marketed at a premium price] probably for the last five or more years and so we will have A2 milk and we will probably be the only cheese factory with A2 milk, so that was another market ploy of what we're looking at and value add our milk. [FARMER 11]

Family is very important to the farmer, with family priorities influencing farm investment choices, and how much time is allocated to physically working on the family farm business.

...Rather have good family than money... [FARMER 21]

...Because once I've got everything right, the plan is we'll work like buggery for the next ten years, and then I want to be able to slow down a bit so I want to be able to get everything right and then slow down a bit and spend a bit more time with the kids before they get too old and they leave home. [FARMER 16]

The choice of family time or expansion is difficult, but ICT expansion goes naturally with increased herd size to give ensure lifestyle values are maintained.

...[I] want to spend more time with the family. That's why I was a bit hesitant with increasing the cow numbers. When we do increase cow numbers we will employ an extra staff member as well. And that's where some of these decisions on auto drafting and things like that... whereas when we AI (artificially inseminate) now, the cows are picked out, we have to physically pick them out and be here for the AI technician. But if I could have the auto drafting system, then they can be drafted out and it's much easier to get the cows ready for the technician. [FARMER 16]

Installation of ICT can create improved work conditions, and particularly reduce after-hours requirements, which often fall back on the owners rather than the staff.

We're going to put cameras in it [herd home], so we can flick over the TV, so we are not going down at ten o'clock at night, like you normally do with the torch, looking for cows and calves, you can just flick over the TV, 'Oh, right – nothing calving – I can go to bed and not worry'. [FARMER 26]

...making things easier to use, that is a big consideration. Even if we didn't make money out of it or just break even then, if it makes it simpler for us then we're pretty keen on that..., it's probably a big emphasis for us, it's got to do the job properly first and then if it makes it better for us, less work or a simpler system than we've been on that sort of thing. [FARMER 15]

Technology makes life easier by keeping the farmer informed on topics such as weather, cow production data, or any abnormal tests from milk tests during collection of the milk by the tanker.

[on what are the benefits of technology] ...certainly keeps us informed, makes life easier. [FARMER 8]

Robotic calf feeders take pressure off the allocated calf rearer. This is generally the owner unless good staff are employed who are well trusted. The calf rearer is often the female in the family farm businesses.

One lady said to me that she cried when it was installed, because it just took so many burdens off her... [FARMER 28]

Milking can become something that is disliked or that is physically too demanding. The farmer may consider the use of ICT either through robotic milkers, or a traditional shed with significant ICT installed, which enables management decisions to be made without being in the shed at milking. Other options a farmer may consider include selling the farm, or retiring to sheep and/or beef farming.

Oh yea, I hate milking cows. When we started 18 years ago, I didn't like milking cows then either, but I did it without much complaint and I did a very good job but I didn't have to like it. Now I'm starting to detest them [cows] with a passion. [FARMER 2]

We'll probably stay here, ... but just run beef stock. We have no debt so we don't have to milk. So yea, no longer is it a matter of having to milk like when we first started. Milking is the only way one can service the large debt... We've already got the internal infrastructure. We've got the irrigation, we've got the fencing, we've got water in individual paddocks,

we've got stock yards. We don't really have to change. If anything it's easier than dairy farming. We don't have to maintain a dairy for a start. You're not buying the chemicals, all that sort of thing. It would be an easy change over, put it that way. [FARMER 2]

I'll be 66 in April, and I didn't want to milk much longer, perhaps next year [I will stay on the property and] I'd run livestock, just have some cattle and I've grown poppies. [Farmer 19]

... we'll probably never go with a share farmer when we retire [because] we still get all the information by still not being in the dairy [the shed is a traditional rotary, with full computerisation]. [FARMER 10]

ICT on farm allows the farm to continue to be an enjoyment throughout life.

...[I am] Enjoying it [farming] as much as probably ever... [Farmer has just installed a new fully computerised shed]. [FARMER 10]

Robotic milkers are attractive due to the desirability of flexible work hours, the less physical nature of milking using robots, through reduced stress due to the decreased requirements to source and retain good quality staff, and the improved reliability of robots in comparison to labour.

I got sick of the mornings [milking] and when you're out with a few friends you have got to go home at three o'clock and everybody's still enjoying themselves, but you have to go back and milk the cows again. [FARMER 29]

These machines, as long as you keep the power and the water up, they don't complain, they don't go on holidays, they are always there. [FARMER 29]

An aspect of robotics that is not initially considered, but has an influence on lifestyle is the improved nature of the cows towards humans. This can lead to younger family members being more involved in the farm, and an improved lifestyle through interaction with the cows being more pleasant due to their improved nature towards humans.

the robots, have been nice to my kids, because I was very much 'it is a bit dangerous in the dairy for you', you know I have been knocked out with the cows, and things like that, I have been kicked and stuff, and you know, you shelter your kids too much, but I have sort of kept them away a little bit from the dairy, they would come in there occasionally with me. But with the robots, I find I am confident that the cows are different animals, they are totally different animals, they are not aggressive, they won't kick, and the kids can be around them and things. [FARMER 31]

4.3.5 Generation

The theme GENERATION describes generations' attitudes towards technology. Older generations attitudes range from not wanting to be involved with ICT, through to embracing ICT to maintain control of the farm once they retire from active physical farm duties. The use of ICT requires the ability to interpret and utilise the large amount of data that has not previously been available to the farmer on a daily basis. This requires a mindset shift in management of the herd from the 'eye balling' of cows as they are milked, to the utilisation and interpretation of electronic data collected in the shed, combined with 'eye balling' either in the shed, or in the case of robotic milking systems, in the paddock. Implicit and linking into this is that if ICT is used for herd management, it must be trusted.

While an older farmer may say that they are too old to use ICT, in actual fact, if there is a reason for them to use it they will. The farmer below, while saying he was too old to use ICT, actually had a robotic calf feeder that was used to raise all the calves. While the farmer's son is also involved on-farm, the decision to install the robotic calf feeder was the fathers (older generation), and it was this older generation that used the system every day (i.e. the father raised all the calves).

...I don't want to be mucking around with a computer. A lot of people do but I'm too old. Too many birthdays. [FARMER 12]

The next generation coming onto the farm faces challenges incorporating ICT into the farming enterprise because the older generation has been doing it one way for a long time.

...I guess yeah, more daunting, just taking it on because it's, I know nothing about it, because they've always done it this way whatever, and it's sort of hard to change it I guess. [FARMER 21]

The confidence to use a computer without something going wrong may be a consideration.

...press the wrong button on a computer and you can go anywhere... [FARMER 10]

Older generations can be happy to use ICT, but may prefer to get the next generation to set it up for them.

...we put the tag in the calf and then it's got to be entered into the computer. Like I don't do that. I've chosen not to do it because I don't want

to have to do it. ...I can do it. I could do it but I chose not to do it... [FARMER 12]

Max is happy to have technology on the farm, as if something goes wrong, he can ring his son - whether it is how to turn on the irrigator, or the fact that the cups keep falling off the cows in the dairy. The below comment is from the son's perspective.

You understand Max's logic with technology, the more technology we put in, the less he understands, and the less he has to do. [FARMER 20]

Technology to a mechanical mind is amazing, the farmer below uses a lot of ICT, with the quote below illustrating a new type of bailer for the silage. Push one button, and it does everything – a novelty. The farmer is actually attracted to this type of system, and bought the first in Australia.

I think it is amazing, the technology that they put in these things, and I could just touch a button and bail. I am quite mechanical, so to touch a button and make something do something, it's just amazing [FARMER 31]

The next generation coming onto the farm to take it over does not want to work the hours that their parents did. The parents observe that the next generation uses ICT to manage the time commitments of a dairy farm to suit these differing lifestyle goals.

Younger generation see ICT as a way to have a life – admirable. [FARMER 17]

Learning technology takes time – if the farmer is not familiar with it, and has no desire or interest in using technology, other farmer's advice may be to philosophically just continue as is.

There can be a lot of time wasted, it depends how your business is set up. If you're a wholly manual or a sole person that's probably a bit older or hasn't used technology before there's a lot of time that needs spending learning how to use technology, which some people wouldn't be able to justify - they'd be better just doing the work and getting on with life. [FARMER 1]

ICT may be used when the decision is made to stop doing any form of physical farm work. The ICT enables full knowledge of everything that goes on in the dairy, enabling informed decisions to be made and implemented and the farm can therefore continue to be

managed by the owner without having to employ a sharefarmer to oversee the milking operations.

[recently put in a shed full of ICT] ...We don't have to have someone with a heap of knowledge to run the dairy... We'll probably never go with a sharefarmer when we retire but we still get all the information by still not being in the dairy... [FARMER 10]

As ICT use expands, there will be an ever-increasing need to be able to understand what can go wrong, and interpret what the ICT is telling the farmer. This ICT interaction skillset is a different skillset to the physical interaction a farmer has traditionally only required.

...the more automation you have I think the smarter you have to be if you are caring for it. Because if you are in Zimbabwe, and your moisture meter says get the centre pivot going, the centre pivot gets halfway around and throws a lead, and it is stuck there, the moisture meter is still saying water, water, water, but you are not here to look at it, it sits in one place for three weeks. [FARMER 31]

If the farmer chooses to install a shed with significant ICT, how the farmer manages breakdowns is a consideration. Some farmers believe there is a need to be able to fix the ICT as well as just use it. This is because of the isolation of the farm, and the fact that most likely if a physical technician is required they may have to come from interstate if the solution cannot be fixed remotely.

...you've got to have the people to fix the technology.... I've got a son.... He breathes technology. And he can talk to technicians anywhere around the world and get the feedback on how to fix things, how it works, what he should have and all the rest of it. Now if you haven't got that ability, what's the good of going down that road? [Farmer 20]

[robotic milkers]...it's well and truly worth the while going to the Netherlands and actually doing the training that their technicians do.... so that you understand completely how the machine works, if there is a problem you can just fix it yourself and there's absolutely no down time on the machine... [FARMER 9]

Robot milking systems are interesting farmers of all ages. The decision to invest is dependent on personal goals, stage of life, and whether there is a next generation to take over.

...if [it] was 10 or 12 years ago, or I was 10 or 12 years younger I think I would... it's getting [sic] the grips of it [the technology], the investment capital expenditure side of it, and the drive to want to do it because I'm 53, 54 next month in June, oh yeah, next month, it's that drive [motivation] side of it that is one of the factors why I probably wouldn't. I can see that it can work and I think it could really work well here on this farm the way it's set up... [FARMER 22]

Robotic milking systems require the farmer to have a better understanding of cow behaviour than a traditional system because robotic dairies rely on the cow to move herself from the paddock to the milking shed and back. This requires a good understanding of how a cow thinks to facilitate this movement.

You have got to be able to see what the cow is thinking. In a lot of ways it is more difficult, because unless you are a real animal person, the system is just not going to work. [FARMER 31]

The younger dairy farmer expects to utilise ICT while managing a dairy farm to reduce the physical time requirements and looks to use ICT to enable the farm to be run differently to how the parents ran the farm.

...I think the younger generation, Anthony's generation who have a completely different outlook to what dairying and work and what all that should be. I think he looks at these things as giving him more time to look at the business. The helicopter view... [FARMER 17]

A University degree is beneficial, but not a traditional approach for Tasmanian dairy farmers. Dairy farming is not an occupation that is considered to require a university degree.

[University degree] ...Surprising how much you do use of it. Someone asked me about it, they said does it help having a Uni degree being a farmer and I said you wouldn't think that you would but it is amazing how much of it you do use. [FARMER 9]

4.3.6 Grounding

The theme GROUNDING encapsulates the need and ability for contact with 'nature' – both the cow and the physical farm.

Some farmers (particularly stud breeders) consider that cows are part of the family, and ICT is not seen to impact on this relationship. This is a stud herd owner discussing the

relationship with her cows and how robots would not impede their relationship with the cows.

[on the use of robots] ...I think we would continue to know [the cows], because our cows are not udders on legs to us. The family sits here and refers to them by name, or numbers - they [the family] all know who they [the cows] are, they [the cows] are like extensions of the family - a bit like pets. [FARMER 28]

Wanting to do the best for the cows can be a reason to use ICT. There is an attraction to ICT that is designed around the cow instead of the cow having to work in with ICT.

[on Robot use]... I can see it actually benefiting the cows just as much as it will benefit me in a lot of ways. ...It's designed around the cow, it's not designed as a machine and then you've got to make the cow work with it. This one is designed to work with the cow, which is the thing I like about that system. [FARMER 9]

A farmer may not be formally trained, however they have an understanding and knowledge of the natural system, land and animals, which has been developed due to years working on the land.

...farmer intelligence. It's a particular sort of intelligence used to describe farmers because they are extremely intelligent in terms of the natural systems. [FARMER 17]

4.3.7 Family farm

The theme FAMILY FARM describes how the family influences what goes on around the farm. Farm succession options vary from no expectation of kids returning to farm, to an expectation from siblings that one will return. The actual taking over of the farm by the next generation can be a slow process where changes have to be made gradually – alternatively large ICT investments are made to make the farm attractive to the next generation. ICT provides the opportunity to involve the whole family in the (cow) side of the farm from an early age through cow records being available on the home computer.

The choice to dairy and even stay dairying may be income related for raising a family. Dairy farming generally allows a stable income to raise and educate a family.

[Question as to why stayed dairy farming] Well, every month you get a bit of money [from dairy farming]. No, we had four children to educate, that

would have been, they went off here, you know they couldn't stay here and a couple of them have done Uni and things like – Beef's not going to get you through that. [FARMER 21]

Kids may help maintain interest in the farm, through bringing back an interest in the cows and the stud herd. This farmer's daughter got him back into stud herds, showing, and selling cattle.

...If we didn't have kids I probably wouldn't be milking cows, because if we didn't have the stud registered side of cows [which daughter has developed in the herd], I wouldn't be milking cows... [FARMER 22]

A couple of generations of family members may be involved in the farm and help as they can.

Mum always has [helped out on the farm] but she had a stroke a couple of years ago. So she's more likely to contribute by looking after Robbie [son] so I can milk. [FARMER 7]

Family farm communication can be difficult, with little communication occurring. This large 700 cow extended family farm consists of two farms, and a café.

They [the family] don't communicate very well. No-one says anything. It probably has become a little bit better over recent years I guess but it's still not the best. [FARMER 18]

Selling the farm may not be considered, even if the kids do not chose to take over. This 400 cow farm has recently invested in a new shed full of ICT, and employs full-time staff as well as two generations having an involvement in the farm.

Yes, I'd like to think we might reach a stage where we could have a share farmer or a manager or something... I cannot see us ever selling this, we've been here since 1920. [FARMER 15]

The next generation may not be expected to take over, in fact may be discouraged from taking over, with the realisation that farming is a life, and unless it is a passion, it is a grind.

...I'll discourage them though I think. It's a good way of making money but you've got to be passionate about it and if you're not it's a grind so I think lifestyle wise there are better jobs to be had. On Sunday morning and Christmas day and things like that, take them into account, it's not for everyone. [FARMER 15]

The next generation wants to spend money to change the way things are done, to improve the lifestyle of farming, but the parents may be reluctant because they are at a different stage of life, and have different investment and risk attitudes.

[talking of differences in investment preferences between son and father – from mother's perspective] *...and it comes back [to what] I always say to him, ...'Yea, the older generation have got everything to lose and nothing to gain and the younger generation have got everything to gain and nothing to lose because they haven't got the capital stake in the short term period...*

[FARMER 17]

The next generation not knowing if they are going to buy the family farm limits capital investment in the short-medium term. The entire capital infrastructure purchases may be 'on hold', or 'on paper'. In this case it is the shed that is not being invested in as it is on the original family farm, although it is recognised that the shed is the next investment required. For example the irrigation investment has occurred on adjoining land owned by the younger generation.

Yes, I don't really want to invest in that until we know that, well the plan is that we are going to buy this place, and that's what we've decided on, but until we have we are not going to invest in capital infrastructure. So that's why we've got all these things on the drawing board but none of them have been implemented as yet ... [FARMER 16]

Family farms can take years to change if the older generation does not step back and let the next generation take over. Additionally if there has been no change for too long, it becomes too late, the younger generation loses the drive to change.

[Discussion surrounding having two generations involved in the decision making on the farm, and how influences the decisions made on the farm] *...yes, you just do little things at a time, which is the way it should be, but at least they [the parents/older generation] will change. A lot of farms, family farms they don't change...they have done it for so long the way their father has done it, when the time comes for him to say okay it is yours, they don't have that, [drive to change] they cannot really change then...* [FARMER 25]

Larger high technology farms may be the end of the family farm.

I suppose my personal opinion is yea it probably is the future of the industry. But that's probably not what I would like. It will probably do away with the little family farming dairy operations like we've got here. [Farmer 4]

Recognising that the next generation may want a different relationship with the farm, such as to put a manager on can be a motivator to use ICT to set the farm up differently.

We run on the leading edge of technology, not the cutting edge of technology, but you know, we must, the place has got to be a better place tomorrow... We have to build this business, knowing that it's going to be successfully run under a manager. [FARMER 20]

The next generation to come home to the farm may do it through own choice, however sometime it is largely influenced by family expectation – including from the siblings.

Yes, it was always on the cards, I have got two older brothers, and neither of them was interested. I was never really keen at from a young age, but the older I got, I went "yes, I quite like doing this". [FARMER 30]

I am the youngest of five kids in my family, but I'm the only one that was interested in the farm, all the other kids got professional jobs, and I was the last one, and I looked to go away, and we had a big family meeting, which didn't include my parents, but all my siblings, and they suggested that I was the last one on the farm, and that I needed to stay look after my parents, in their age, and run the farm and things, so I did. [FARMER 31]

Succession plans should be ongoing, and one of these options is that a manager will run the family farm, rather than the next generation directly. If the next generation still wants to maintain an insight to what is going on, this is a great motivator to full ICT installation in the shed and irrigation systems in particular.

We're getting our fencing done, we're getting laneways, we're doing irrigation, he's [son] bringing in the computer system up where they [son and his family] can bring in somebody and they can take care of that. But we have to build this business, knowing that it's going to be successfully run under a manager. He's [son] got a family and everything else. [FARMER 20]

More than one family can be reliant on the farm income, which may necessitate additional off-farm income to be sourced.

...there's really three families, like my father's supposed to get an income as well and we were very lucky on this farm because my father had an off-farm income for that [our] family. My wife works, my brother's wife works. Each family has an outsource income as well so that supplements, and makes it a bit easier for us to do what we do. [FARMER 3]

Robots will allow a family farming tradition to be carried on despite health issues because they remove the need to stand on concrete and milk cows in the smaller to medium sized herds where employing labour is not an economically viable alternative.

[son] cannot work on concrete because of his arthritis, so that is why he doesn't milk, it doesn't mean he doesn't like the cows, he is very interested in the dairy industry, he just cannot milk. So if we had a robot, it would mean he could supervise the dairy herd without having to be on concrete for seven hours a day – at least. [FARMER 28]

An increased level of ICT in the shed provides an opportunity for the whole family to be involved with the cows without having to be at the shed. In this family, the farmer has found the cows to be better tempered around humans after introduction of robotics. Because of the cows being safer to interact with, the kids are allowed to be around the dairy interacting with the cows more. Additionally, with the massive amount of data collected, it provides an ideal opportunity for the kids to get involved in the data interpretation.

The eldest one is amazing, absolutely amazing, she can train cows on the robot, the little one will go on the computer in the office, and bring up the cows who are late, and she will come out with a list of cows with other health problems, and she will come out with a list of cows 'what is going on with these dad'. [FARMER 31]

4.3.8 Technology adopters

The theme TECHNOLOGY ADOPTERS describes how some farmers use ICT to stay interested in the business, to provide a challenge, and are looking ahead and predicting future uses.

ICT is embraced as the exciting way forward for dairying.

I think it [technology] will become increasingly important, I think that the farms that do have the technology with the big neck collars around the cows, and then they are scanned and you can immediately see what their milk production is, and if they have got a problem, and heat detection - I think it is all really, really wonderful... [FARMER 28]

Large herd farmers are interested in robotics and are waiting for the technology to become relevant and accessible to them without the cost of a new shed – i.e. retrofitting.

If they could make a robotic arm to put cups on a cow on existing rotaries, that would be magic and I don't know why they don't look at it because for all the technology that's about they should be able to do that. [FARMER 10]

4.4 LABOUR

This cluster relates to the labour required on a dairy farm. HARD WORK describes dairy farming being hard work; both physically and mentally. TRUST RELATIONSHIPS has two main focuses. The first relates to the farmers' trust of staff to use ICT, and the second the process of trusting ICT to look after the cows without their (the farmers) presence. CHANGING FUTURE addresses how ICT use on a farm changes the job description and skill set required for staff. This also covers farmers' attitudes towards staff and whether their staff is expected to interact with ICT. The following provides a detailed description of the themes grouped in the above cluster.

4.4.1 Hard work

The theme HARD WORK describes dairy farming being hard work. Milking is hard work physically, and it causes wear and tear on the body. Extra labour may be employed to take this into account so the same people do not have to do two milkings per day, which would entail seven hour work day just milking. ICT has a role in this in that it may be used to replace labour, or reduce the physical or mental stresses involved with milking.

[milking] ...is about 4 hours in the morning, 3 to 3.5 hours sort of thing. I guess I've got more staff just to accommodate them not having to do too many twice a day shifts because it's a reasonable bit of wear and tear on the body. [FARMER 6]

Calf rearing is physically demanding, particularly if milk is being carried around in buckets, or calves are in large groups that require physical handling.

... I need a bit of muscle these days, we hand carry our [calf] milk [in buckets] around wherever it goes. [FARMER 24]

... Calves – bloody hard work. [FARMER 17]

The physicality of feeding calves is a reason to get a robotic calf feeder.

... I don't have to carry all those buckets anymore. [FARMER 29]

There are occupational health and safety issues around robotic milkers due to staffing numbers. Because robotic milkers reduce the number of staff required to be on the farm at one time, less staff are available for two person jobs such as certain stock handling events (including get cows unstuck from places). The below farmer has robots.

[Are robotics better for farm occupational health and safety] not really, probably if anything there are some concerns with this, because of the money you've got to invest it has got to be a one man operation, so when the phone rings at three am, one man, or one girl has to go down and get a cow that is stuck in a gate that is half open or whatever out, there are not two people around, whereas most of the other dairies, in a lot of the season, there is often more than one person about, so there is one person keeping an eye on the other person. And for heavy lifting tasks and stuff like that, there is often two people about. This farm, you can just cannot afford to have another person about. [FARMER 31]

Farmers may be too tired at night to use a computer after a full days work.

I don't use the computer too [sic] - because as I said, when I come home of a night, I've had it. Now I don't want to be mucking around with a computer. [FARMER 12]

4.4.2 Trust relationships

The theme TRUST RELATIONSHIPS has two components. The first relates to the farmer's trust of staff to use ICT and the second the process of trusting ICT to look after the cows without their presence.

The first component of this theme covers trust of staff to use ICT. If staff are considered a limiting factor, there are two choices for the farm owner. The first option is to keep the shed basic (i.e. little ICT), so the worker does not have to deal with ICT. This option results in no individual cow information being recorded during milkings, and requires staff to be skilled stockmen because labour is relied on to manage herd health issues. The alternative view to manage farmer perceived poor quality staff, who are not trusted to use ICT, is to 'lock down' the ICT and have a highly ICT based milking system. This turns the staff effectively into human robots, with the ICT taking care of the health and management of the cow throughout the milking. In this format, the milker has no real incentive to interact or interpret the information gathered using ICT. Some farmers wish to have the staff involved in the milking process and data collection on an ICT enabled milking shed, and make it a priority to have a system that is easy to operate for everyone concerned, and to also allow and train the staff in the use of the system.

ICT is seen by the farmer as a way to deal with decreasing labour availability and poor labour skillset. Quality and quantity of labour is one of the largest issues in the dairy industry today, particularly in Tasmania.

...I think technology is probably going to be the solution to our labour issues, or lack of labour - available labour... [FARMER 28]

[staff don't mind new technology being put in place] They don't mind, it's just a matter of training them in the correct way to make sure that, you know, the new stuff that you get, make sure they understand how it works. That's a bit more work to do, something you've got to train them in but it is good for the business. [FARMER 1]

Farmers may want staff to have minimal interaction with ICT in the shed, preferring to do all the data entry and maintenance of the cow and herd records themselves.

...We haven't really showed them much – only as much as they need to know. They can actually enter the cows on it [ALPRO] when they've treated them but we don't let them. They've got to write it in the book and then we just enter it in. [FARMER 10]

Other farmers want staff to be able to maintain and use a herd management system, so an easy to use one is of priority. This enables both staff and the owner to easily input information.

...The simpler the better especially if you have someone working for you and you don't have to worry about them trying to have a fight with the thing trying to put information in... [FARMER 9]

The second component of this theme is the farmers' trust in ICT to record and highlight animal management and health issues the farmers would otherwise see themselves. With trust, the farmer does not feel like they need to be at the shed during milking. The herd management system recognises cows that need attention, and separates them and any other cow requested during milking (this is called 'drafting' the cows). Information about the cows such as milk volume and somatic cell counts are recorded for future review. This is demonstrated by the farmer below, who on a particular morning needs a certain cow kept back after milking, but cannot be there in person.

...certainly makes it easier as far as the staff goes... She will be drafted out and they won't have to do anything. She will just be in the yard. [FARMER 15]

With daily individual cow production being recorded the farmer does not have to be in the milking shed to know what the cows are doing.

...not being there we still know what's going on... [FARMER 10]

One of the farmers milking with robotics commented that they know far more about the individual cows now than what they did when the cows were being put through the traditional herringbone or rotary shed.

...But if it comes to the crunch and you really want to know the nitty gritty you know way more with these machines (robots) than you ever know on a herringbone or a rotary. [Farmer 29]

If ICT is not trusted for herd management use in the milking shed during milking, there is a fear by the farmer that the technology will miss important herd management events, such as cycling cows, or herd health issues such as high cell count cows, enabling this milk to enter the vat unnecessarily.

No, I wouldn't [trust ICT in the shed]. I can just see that there is a lot more that can go wrong. I mean it's only got to be missed for a couple of days and you have probably missed all those cows that were cycling or you have put bad milk from a couple of cows with a high cell count through – and not been picked up. If the machine does falter a little... [FARMER 16]

Other farmers believe that interaction with the individual cows is vital to cow health. And ICT cannot replace or supplement human contact.

[robotic dairies] there's no hands on, there's no one paying attention anymore, it's just easy, it's quick I think its [interaction is] vital to cow health, your quality of your milk and to me. I just often wonder whether people have become robotic dairies and milking machines and what not and they're putting it all down to time. You should only be in the dairy so long. You should not be in there any longer than this, so 'hey' we'll do technology and get us out. Don't give a stuff what the milk's like. [FARMER 2]

4.4.3 Changing future

The theme CHANGING FUTURE addresses how ICT use on a farm changes the job description and skill set required for staff. The use of ICT also changes farmers' attitudes towards staff and whether the staff is expected to interact with ICT.

The change in the land use from farming to tree plantations has changed the dynamics of rural communities. Rural communities are smaller because less staff are needed to maintain tree plantations compared to agricultural use such as farming, and particularly labour intensive dairy farming. It is difficult to attract staff to remote locations, and so therefore ICT is seen as a way to reduce labour requirements.

[Does technology have a place on your farm]... Yes, we just came back from Europe in September and saw lots of robots over there...we are quite labour intensive... It's hard to get employees out here like because a lot of the area is now in tree plantations. So it's a little hard to get employees back here, like if they come from the coast, they've got to have somewhere to live.
[FARMER 5]

Having a fully ICT equipped shed does not affect the ability to attract staff.

It doesn't matter how flash your shed is – people just don't want to do the job. [FARMER 9]

Farmers have to balance the benefits and potential risks associated with educating their staff in the use of ICT utilised in the milking shed, and the level of access that staff are given to make changes to the ICT settings in the shed.

...It will be a balance of what is too much. I don't want them playing with their [the cows] diets, but if she [the cow] is not getting any grain, I would like them to be aware of that. [FARMER 30]

Staff will need to be receptive to using ICT.

Unless I'm showing him [employee] how to enter a cow into it, he's loath to touch the thing but I've got another young girl who is 19 or 20 I guess, just from a different generation and has used computers a lot more and knows that you're not going to blow them up if you turn the screen on or anything. She's found all sorts of things on there and she shows him [her co-worker] things and she's only been here a little while. [FARMER 15]

This follows through to the desire of making the job less physically demanding and more pleasant for owners and staff.

[Reducing physical side of farming] Yea I think that's one of the reasons we look at things like auto-ID, and auto-drafting and cup removers and a more automatic calf rearing thing so in terms of labour, whether it's family labour or employed labour... [FARMER 17]

It was a big job in the other shed and you needed experienced people so physically it was a lot harder whereas now it's only hard for the cups off bloke even though he doesn't actually take cups off. The cups on guy, it's been a nice job there it's all nice and clean, [the] cows have to mess [defecate] when they are in the second last bail, just before they are about to back off. [FARMER 15]

A milking shed with an integrated herd management system, particularly in a large herd makes milking less stressful for the staff.

...it makes it a lot easier for the staff down there, like the person who puts cups on, they don't have to worry about when that cow was treated or counted. Withholding period [of drugs] like you said goes into the computer [it is therefore known how long milk from a treated cow needs to be separated out from the rest of the herds milk]. [FARMER 15]

A shed full of ICT requires staff with less stockmanship skills.

Once the shed is fully functional, the staff won't have to have as much skills as what they used to have down here... and also their stock handling skills don't have to be as good. [In old shed] if you weren't a good cow person, if you didn't know how to handle them and you couldn't see mastitis and stuff. So in the old shed there were certainly more and more skills required then up there [new shed]. [FARMER 30]

Robots provide the opportunity to attract into the dairy industry an educated workforce that is interested in dairy farm management. This workforce may not otherwise be attracted to the dairy industry due to the traditional work hours associated with the dairy industry such as early mornings.

Well, one of the things I think is really good with the robots, you can get people that are just better at managing things, because how many people have got a good education still want to start like four o'clock in the morning or five o'clock in the morning? They say, oh, bugger that. But no, we start like seven o'clock - six, seven o'clock, with calving we do earlier, but otherwise I get up about half past six or something, have a bit of breakfast and a cup of tea and then you go out and check everything, set up the paddock for the day and you're done. So you can get, like these people with better skills. [FARMER 29]

4.5 PRACTICALITIES

This cluster relates together themes that describe the practicalities of human – ICT interaction. INFRASTRUCTURE covers Internet connections, including NBN (National Broadband Network) attitudes. Copper Telstra lines are limiting for the adoption of ADSL to some farms, requiring wireless or satellite. Wireless broadband offers mobility advantages. RELIABILITY looks at the reliability of ICT being promoted to dairy farmers. Support may be four hours away, which influences some farmers' investment decisions. COMPLEXITY describes how systems can be perceived to be complex. COMPATABILITY includes compatibility issues between ICT systems, both Australian and internationally designed dairying systems. COST INFLUENCE describes cost motivators pertaining to ICT use. Shed ICT is financially best to be put in when the shed is built, as retrofitting is expensive. In preparation for a new shed, minimal investment is made in sheds that are reaching the end of their useable life due to size restrictions or other reasons. TIME CONSUMING captures the problem that data entry takes time and if it is not approached with the right attitude, and done effectively (such as at the shed while milking is taking place, or recorded automatically so the farmer does not have to input data), can be a reason for the farmer to stop using ICT. If only basic essential information is put in to herd management systems due to time or other constraints such as compatibility with other electronic systems, this can lead to less than optimal use, and the software not being valued. The time spent in the milking shed is a large driver for change. HERD SIZE encapsulates the concept that large herds necessitate ICT if cows are to be treated as individuals. Not all farmers consider it necessary to treat cows as individuals. Some farmers do consider it important to treat each cow individually however do not trust ICT to assist with this. This theme links in with the labour theme of TRUST RELATIONSHIPS because labour is a significant factor in large herds. The use of ICT offers a safety check to make sure the right cows get milked in large herds where individual cows may not be known due to the owner not milking, or there being rotating staff (permanent or casual) at milking times putting cups on. CAPITAL LIMITATIONS includes the concept that starting up a dairy farm requires a huge investment. Unless the farm is a family one, young farmers have capital limitations that limit their ability to invest in ICT. The installation of a new shed for any farmer is a major capital investment, however robots may be viable if a new shed is required anyway. TIME SAVING incorporates how ICT has the ability to save significant time in the milking shed, in labour, and also data inputting as data is recorded electronically without operator inputting required. The use of robotics frees up the time traditionally allocated to milking enabling other farm tasks or

personal activities to be undertaken. FINANCIAL RECORDING represents time saving and ease, with savings in accountant's bills being significant when financials are done electronically.

The following provides a detailed description of the themes grouped in the above Cluster.

4.5.1 Infrastructure

The theme INFRASTRUCTURE covers Internet connections, including NBN attitudes. Copper Telstra lines are limiting for the adoption of ADSL to some farms, requiring wireless or satellite. Wireless broadband offers mobility advantages. Interest in the NBN is mixed, with mixed views on when it will be available. Farmers' thoughts are that if they cannot 'even' get mobile phone reception, why would they have expectations of being able to get the NBN. Wireless Internet (i.e. 3G or 4G) available through mobile phones and iPads may be seen to be replacing the need for fixed Internet (NBN).

Some farmers' do not have copper phone lines that are good enough for ADSL, and these copper lines are not seen as a priority to upgrade by the phone company. This makes ADSL unavailable to these farmers'.

Well I guess that was one thing about it, very frustrating. I mean you knew it was slow it would just tick away there and just never receive these emails. It was a bit frustrating though because the phone line is only, we've only got four pairs coming to this house and my father's house, on sort of a branch line here. It's not the best and they [the phone company] are not about to update it. [FARMER 1]

Copper lines that are incompatible with ADSL force the farmer into using alternative sources of Internet. Satellite and wireless are the two main alternatives. This farmer has been forced to use a wireless broadband connection since ADSL is not available.

I've just gone with the wireless broadband. I can take it with me anywhere, which is another advantage and it's actually cheaper. [FARMER 1]

Farmers may have little interest in connecting to the NBN if they consider their current Internet connection to be providing the level of Internet access they require.

I cannot see the point. I cannot justify the cost, actually. It's probably the mentality, that if it works, it is not broke, why change it, why fix it? That's working for us, it is not a problem, it works for the amount that we use. [FARMER 2]

Some farmers are following the NBN rollout, and are taking the time to go to NBN community meetings, and understand how the NBN will be provided.

The guys from CSIRO and they said they're basically going to put it up from your TV transmission towers and so we'll get broadband basically through that way. [FARMER 11]

Where farmers are running into data or speed limitations with their current method of accessing the Internet, the NBN is of interest.

...would be great because it's a pain waiting if you've got slow Internet. [FARMER 6]

Farmers do not believe that they will be given the opportunity to be able to connect to the NBN for some time.

I'll believe it when I see it... One day I guess it'll [the NBN] come past. [FARMER 6]

Farmers are considering that wireless Internet access through mobile devices is an alternative to fixed Internet such as ADSL and the use of a separate computer.

A lot of people are going wireless now, all of these smart phones and everything; they are taking away from all the computers too aren't they. [FARMER 25]

Farmers' do not believe they will get the NBN because other infrastructure, considered more fundamental (such as that providing mobile reception) has not been provided to their local community yet.

[is the NBN going to get to you] Don't reckon. Like in Mole Creek out here, there's probably 1500 people, they still cannot get mobile reception. So if they cannot fix something like that and everyone in town is going to have whizz bang Internet... [FARMER 7]

4.5.2 Reliability

The theme RELIABILITY investigates the reliability of ICT being promoted to dairy farmers. Support may be four hours away, with this influencing some farmers' investment decisions but not others. A factor in poor ICT reliability is that software upgrades may be rolled out

from the ICT provider without system testing being completed, leading to the farmer having problems with reliability of ICT when system problems occur due to the upgrade.

On one farm, milk meters were put in for somatic cell count, but the promised technology has not eventuated yet. As the farmer explains:

...primary reason for putting the milk meters in there, the way they actually sense the flow and the volume to activate the cup remover. We could have gotten a simpler manual one, just a manual flow meter which would have done the same job but when we bought them they were planning on these milk meters being able to do conductivity which would help with mastitis which hasn't eventuated of course... [FARMER 1]

Farmers are sold systems with the promise that the system can do things it actually cannot do. This is demonstrated by the following farmer's explanation. The farmer below was sold a system with the belief it was compatible with herd testing. However despite being told this, it was not possible to herd test using this milking system.

That was the selling point at the time. I mean it does also give you your flow and we did get the test bottles with it for the flow and the volume. Though it is more work to test with those bottles because they test a different volume/percentage of milk than what the herd recording centre does. So the herd recording centre tests, I'm not sure what percentage they are, but they're a small percentage of what these meters take, so if you're going to test with those you actually going to have to take the bottle and empty it into another bottle and then write on the bottle 'litres' that was on the meter. [FARMER 1]

Another issue with ICT reliability is that overseas designed systems require adaption for Australian systems, as this farmer explains:

In Holland, when they do the software upgrades, the cows are in the shed. So it might work there, but then you come here [into a grazing system] and then you end up with some sort of problem and, you wonder if you did something wrong, or is it somewhere in the software...' [FARMER 29]

Some ICT such as heat detection, while being marketed to the farming community as a viable herd management option is not yet considered to function well enough by the farmer to implement. Using ICT for heat detection is an example of a system not yet reliable enough for the farmer to use. These systems automatically identify cows that should be mated, and the system drafts them off after milking without any human

intervention. Farmers' are not currently confident that the system works well enough to be relied on, as these farmers explain:

... I'm not sure that they're accurate enough. You've still got to spend time. I'm not sure how well set up you have to be with antennas and that around the farm to actually get an accurate reading on movement. And I still think you've got to spend time looking at them. [FARMER 1]

... I got too many false drafts in there. So if you get a cow that's on heat and another one is just jumping and carrying on, so her activity goes up but she's not on heat, and she gets drafted as well. [FARMER 29]

Electronic identification in herringbones may not reliably identify the correct order that cows come into the shed, and hence identify which cow is being milked with which set of cups. In a herringbone the system assumes the third set of cups will go onto the third cow that entered the shed, however cows may change order once they pass the electronic identification reader, and the system has no way of knowing this, resulting in inaccurate identification of cows. As this farmer explains:

No, we've looked into that [electronic cow identification in the shed] but because our cows, they don't come in single file. For them [systems that read the RFID tags in the cows ears, enabling electronic individual cow identification in the shed] to read the NLIS tags they have to come in single file so we'd have to close the opening and Kim didn't want to close the opening because it would slow down the flow. So I just know the cows, is the answer. [FARMER 4]

Data loggers are a way of testing moisture levels in the soil. Farmers use this information to decide when to irrigate. However some farmers have found these devices not to be reliable, and that manually digging a hole with a spade is just as effective. As this farmer explains:

... I think it's just as easy to go outside with a spade and dig a hole, because we were getting some false readings as well and we were irrigating too late, we were starting too late whereas actually I remember saying to the rep once, we're not really growing the grass that we did and he got a spade and dug a hole and then you can see for yourself straight away it was wet on the top and dry down... [FARMER 11]

Smartphones are considered less durable and reliable, with this influencing the use of this ICT. As this farmer explains, he decided to use a laptop and connect it to a durable mobile phone, rather than buy a smartphone.

The laptop because I looked at an iPhone and a blackberry and they don't seem durable enough for lasting in the operation I put things through. So the last phone I bought one I was looking for a rubber coated one but I couldn't find a decent one of them that would receive enough so I ended up [well with a Nokia] using my laptop. It's probably not as robust ... [FARMER 1]

The perceived reliability of a shed with ICT, and the ability to get an ICT-related problem fixed in a timely manner influences the farmers' decision to use the technology. This farmer explains that he has considered these factors and decided to have a shed with minimal ICT so he can fix any problems that occur during milking because fixes would be mechanical in nature rather than ICT related and therefore within the farmers' skillset.

[basic low ICT shed] If something goes wrong we can usually fix it. That is the biggest issue being down here, a lot of the guys up here have gone for the Rotary dairies with all the bells and whistles, but something goes wrong, it is four hours to the closest service technician. [FARMER 23]

Other farmers may choose to install a shed utilising significant ICT despite a considering this type of shed to be less reliable. In this instance risk-management strategies such as installation of generators, or ensuring the shed can still be used to milk the cows even if the ICT is not working may be employed. This philosophy is demonstrated by the comments of the farmer.

I made sure that even if things fall over than this dairy can operate on pretty much a manual basis. Even if the computer shuts down, we are putting in a generator to run the whole lot anyway, so if we get a power outage I can keep going. [FARMER 30]

4.5.3 Complexity

The theme COMPLEXITY describes how systems can be perceived to be complex by the farmer. Some farmers' consider the complexity of the technology to be a failing in the industry, others believe ICT is complex, and hence expect complex ICT systems. Some farmers observe that due to the complexity of the ICT system, regular interaction is required, and other farmers say the technology looks complex, but is not that bad. In

summary, all the farmer comments below identify that ICT and complexity are considered together.

The farmers comment that training would not be necessary if technology was not so complex.

Now that's the failure of the [x] system, that is the failure of all this technology in dairying, is that we've got to have trained up people. [FARMER 20]

The [new] program's a bit confusing. But that's probably because there's so much in it. But we will get there. We used to just use [the old system] which was a very basic one I suppose, so going from that to this is takes a bit. [FARMER 7]

... it looks complicated. You undo this box and all these lights flashing and there's numbers there but it's not that complicated once you do it. [FARMER 12]

Below the farmer comments that if the system was more intuitive, and less complex, it would be easier to remember how to use the system when needed.

... Time is a big thing, like when you're not using something that often you tend to get rusty and forget how to do bits [inputting cow information into herd management software]. [FARMER 27]

4.5.4 Compatibility

The theme COMPATABILITY encompasses compatibility issues between both Australian and international dairying systems.

Operating system changes force herd management software upgrades due to a lack of support for old software.

Upgraded my computer to Windows 7 and then they tried to load my [original herd management software] on and it wasn't compatible. So then they wanted to take my brand new computer up to Gladstone to reload my old [operating] system, and I'm thinking, 'that's not going to happen'! What are my other options? MISTRO was something I had looked at, they'd given me some information at Ag Fest so I had already looked at it. So that gave us the opportunity 'OK, let's switch over to MISTRO. [FARMER 4]

Compatibility between systems is a problem for farmers and this is preventing ICT integration because the farmer cannot find a resolution. As this farmer explains:

Well at the moment we haven't been able to integrate too much of that stuff. So I haven't really found an answer to that. I didn't want to buy another system to put the automatic drafting in as a stand-alone system. I wanted to try and integrate it into the weighing system. So I was waiting for these guys and the local rep who comes around he hasn't been back to me in the last 6 months about it, so I'm just envisaging that they haven't got it sorted. [FARMER 1]

Incompatibility between systems can be unanticipated when installing new systems. As this farmer explains:

...I couldn't get the two systems to talk to each other either. It was a [x system] gate... I ended up having to put a whole [other manufacturers] system in. I thought it was going to be simple... [FARMER 15]

A further example of incompatibility between Australian standards and international systems is that some overseas systems require individual cow identification to function, yet they are not able to recognise the Australian compulsory National Livestock Identification System (NLIS) tags. These tags are compulsory for every dairy heifer in Australia to have. As this farmer explains:

This system doesn't recognise the NLIS tags, so it is a bit of a nuisance, you could put them [the NLIS tags] in the little calves, and bang you have got their life number if you like. The system doesn't recognise that, and at nearly \$300 a collar, by [the] time you put the gear on it, you cannot put a collar on calf, because we haven't got that much money, so you cannot put a collar on them until they calve as heifers, or until you are breaking them in, so your identification is still with tags in the calves. [FARMER 31]

Australian designed ICT that is integrated into milking sheds is compatible with the industry standard systems of herd testing. Herd testing is done by many farmers to enable estimation of an individual cow's milk production by collecting a standardised sample during a milking, which then gets sent away to be analysed.

All we do is plug the computer into the printer and it spits out a sticker for each cow. [FARMER 15]

4.5.5 Cost influence

The theme COST INFLUENCE describes cost motivators for ICT use. Minimal financial investment of ICT is made in milking sheds that are reaching the end of their usable life. It

is financially best to invest in ICT when a milking shed is being build, with farmers finding retrofitting to be uneconomical.

New shed ICT is attractive, but not economically viable in the old shed.

Because our dairy is twenty years old, fifteen years old so we've sort of, at that time that technology wasn't available so then so then to upgrade to the new technology, it's expensive to change over. So we were sort of in that in between time, investing in other things, you know, gone through with the split and now we are sort of, now that we are milking more cows we need to... We like the new technology but we just cannot afford it. [FARMER 6]

To retrofit a rotary to make it a one person shed is considered expensive.

But to put in a one person shed you have got to put in cup removers, automatic drafting, and automatic spraying, so it is a big expense. [Farmer 25]

The best time to put ICT into a shed is when it is being built. This farmer put in a fully automated new shed the same time as his neighbour put in a new shed with no ICT. When it is not mating time, this farmer's shed can be run with one person, whereas his neighbour referred to below, needs three people all year round – mating or not.

In two weeks' time when we've finished mating, one person will go and milk our cows. So just our labour saving alone. Now any given day, I need one person, they need three. So there's where cost savings come. I spent \$100,000 at the start, I'm probably going to get \$50,000 back in milk in the first year, so it's paid for itself in the second year and I've got the labour content saved already. [FARMER 20]

Farmers changed to the faster satellite broadband when the government offered a financial incentive to do so in the form of a rebate.

...when they were giving away the money to put the dish on your roof. [FARMER 23]

4.5.6 Time consuming

The theme TIME CONSUMING describes the sensitivity of the farmer to the time it takes to enter typically cow data into the computer. Data entry takes time and if not approached with the right attitude, and done efficiently (such as at the shed while milking is taking

place, or recorded automatically so don't have to put in data...) can be a reason to stop using ICT, or for the less than optimal utilisation.

ICT systems may not be used if the time to input the information is perceived to be more than the benefit gained.

I had it all on - I had Easy Dairy, really good but it took more work putting it on the computer, then I actually got out of it. [FARMER 25]

Some farmers recognise that it is important to keep their herd management system up-to-date with the most current information and are willing to pay for this to be done if they choose not to do it themselves.

Yes, it is slightly dearer...I think it is \$.50 a cow or something like that, well for that I can write them out and someone can type it in. [FARMER 24]

Data entry is easy in systems that allow data entry at the shed, and where the data needs to be entered for the cow to be fed. As this farmer explains, having to regularly enter a couple of cows into the system every milking after they calved is much more manageable time wise than having to sit down and enter large numbers of cows at once.

This system because it's in the dairy and you know we have to enter in each cow each day. So the job is done, all the cows that are calved, all the information is entered into it. [FARMER 15]

4.5.7 Herd size

The theme HERD SIZE encapsulates the concept that large herds necessitate ICT if cows are to be treated as individuals. Not all farmers consider this a necessity, and some don't trust the ICT to do this. This theme links in with the labour theme of 'trust relationships' because labour is a significant factor in large herds, and 'cost influence'.

ICT offers a safety check to make sure the right cows get milked in large herds where individual cows may not be known due to the owner not milking, or rotating staff (permanent or casual) at milking time.

We had one [cow] break in [to the milking herd] yesterday out of the dry mob and the alarm [in the dairy] went off [because each cow has electronic identification and therefore the computerised milking system recognised she was not meant to be in the herd]. It was handy... We might not have

known, we could have compromised the whole vat of milk [because if her milk had gone into the vat the milk would have been contaminated].
[FARMER 15]

Large herd size may necessitate ICT for the safety of cows if a dairy farmer chooses a feeding system that uses high levels of grain input. A cow must slowly increase her grain intake over a period of time to avoid acidosis. High levels of grain may be fed to milking cows to give them the energy they need to produce milk, whereas dry cows do not need this level of energy. By having electronic cow identification, a computerised feeding system can feed each cow individually the right amount of grain specific to her requirements, allowing a cow to enter the large milking herd when she calves starting off on a low intake of grain even if her herd mates are receiving more grain because they have been producing milk for longer because they calved earlier.

... our main reason for putting it in would have been so that I could ramp the cows up on the first day of calving and not make them sick. [FARMER 15]

Robotics for large herds is a technology not yet developed to a commercial level for farmers, however there is significant interest in this prospect from large herd owners.

Having the robot set up so that it can actually put through three hundred cows an hour makes it relevant to someone like us. [FARMER 6]

4.5.8 Capital limitations

The theme CAPITAL LIMITATIONS includes the concept that starting up a dairy farm requires a huge investment. Young farmers irrespective of whether the farm is a family farm have capital limitations, which limit their ability to invest in ICT.

Jane, she would have been a good milker but I said no because I reckon the best thing is to stay away from it... I feel sorry for young ones, the capital you've got to fork out to start. A lot of them are going to share farms now, and start off that way. [FARMER 19]

Robots are a huge capital investment only currently a viable option if a new shed needs to be built or the substantial modifications required make this cost prohibitive.

When you get the robots, you have to do it in one go. Like a lot of older sheds, one year they do cup removers and another year they do this and another two or three years later they do something else. So you can do it a step at a time. [FARMER 29]

... last quote we got to actually upgrade the dairy to be able to milk 250 cows comfortably at, it was about \$600,000. As opposed to putting robots in that will do the same job, it was \$680,000 for the robots, I mean jeez it's a no brainer really. You do away with the labour that way. So the economics of getting robotics is getting a lot closer to what we want. [FARMER 9]

4.5.9 Time saving

The theme TIME SAVING captures the importance of saving time.

ICT has the ability to save significant time in the milking shed. Once auto ID is put in, this enables herd management to be accomplished quicker in the shed through automated feeding, drafting, milk recording, and heat detection. It allows tasks to be planned and inputted in a planned fashion that is seen to be of benefit to farmers who trust the technology, and wish to make milking time quicker and easier.

... any time saving we can achieve through technology then we'll certainly look at that. That is high on my priority list... [FARMER 16]

[putting in robots] ...what we were focusing on, was trying to free me up so I didn't have to be around really, so we could focus on running the business... [FARMER 31]

Robots save the farmer the time of having to milk the cows. This extra time is utilised doing other farm activities that are beneficial to the running of the farm.

...if we go robotics I will have time to walk the paddocks and I think time that you spend walking the paddocks is time well spent. [FARMER 9]

4.5.10 Financial recording

The theme FINANCIAL RECORDING encompasses use of the computer for financial purposes, such as budgets and GST. The GST was a stimulus to doing finances using a computer.

...That is the one thing we do use the computer for, doing a lot of budgets, and doing all the figures. [FARMER 25]

The time saving and ease in doing finances electronically has been significant for those choosing to do so.

I did the accounts in half an hour, and didn't have to write a cheque. If I was to do those accounts the old way it would probably take me three hours. The use of the computer as far as bookkeeping goes is a massive time saver. It allows me to pay the bills on the last minute of the last day of the last month sort of thing. [FARMER 8]

I used to have a girl come in to do the accounts the old fashioned way and we'd sit there for two or three hours doing it and now I can do it myself and it took me half an hour. [FARMER 8]

4.6 EXPLORING OPPORTUNITIES

This cluster groups together themes that express the farmers' exploring of opportunities, and how this experience influences farmers in the decisions they make around the farm. SUPPORT explores factors such as teaching how to use software and milking shed ICT systems or other ICT devices. Challenges to receiving ICT support include physical distance and differences in international time zones. Family members, and other staff provide support. This theme also captures the effect that no support by family and/or industry has on ICT use. INDUSTRY NOT LEADING looks at industry issues which are too complex to be changed at an individual farmer level, and which influences attitudes towards ICT. INFORMATION SEEKING captures exploring opportunities by information seeking, and the decision making process. Influences such as face-face with other farmers, family members, or industry members; organised trips; farmer groups, and through industry contact are explored. The information may be sourced locally or internationally such as via the Internet. LACKING DRIVER represents the concept that sometimes 'there is just no reason to' use ICT. Farmers are open to the use of ICT but may see no benefit or need currently. The ICT may not fit in with their current management needs, or alternatively there may be other priorities. CONVERGENCE encapsulates all of the farmers' interaction with a mobile phone, including the opportunities that can be gained and the way mobile phones have changed how the farmer does business. CONNECTED encompasses everything to do with being 'online', which includes the use of a computer. This theme explored the issues surrounding access. The use of mobile phones and smartphones has been specifically identified in another theme CONVERGENCE.

The following provides a detailed description of the themes grouped in the above cluster.

4.6.1 Support

The theme SUPPORT describes all the support factors surrounding the use of ICT. Factors covered include teaching how to use software and milking shed ICT systems or other ICT devices, and support provided by family members and other staff. This theme also captures the effect that no support has on ICT use.

Members of the extended family – normally their kids or partners contribute with inputting of data, knowledge of how to do a task, or organising the purchase and implementation.

“If I get anything long to write [type], I normally get my wife to write it for me”. [FARMER 23]

... When he [husband] wants to know the weather, it is ‘Get on to the Elders site for me will you – look this up’. He can do it if he really wanted to. [FARMER 22]

The initial experience of using a new piece of ICT (in this case a laptop computer) may not be a positive experience without the right support. This farmer in his 70s bought a laptop computer and installed broadband because he wanted to learn how to use a computer. This initial experience has currently put him off from trying again.

... I have a laptop and I have had it about 12 months and I haven’t used it... I bought it with very big intentions, and no one will help me. I have asked for help but it's not forthcoming, even got broadband on. I’ve even been paying for broadband 6 to 10 months I suppose and I've never used it.... They said to play with it, it cannot hurt. The first time I did it I locked it up and couldn’t turn it off. [FARMER 13]

4.6.2 Industry not leading

The theme INDUSTRY NOT LEADING describes problems the farmer faces, or problems that farmers encounter within the industry sector, that industry bodies have a responsibility to address.

Australian ICT investment is lacking – it is believed that Australia should be developing its own robotic systems rather than relying on European and American ICT which is developed primarily for barn systems.

... Well this is New Zealand and Australia's fault, in a lot of cases, because this [robotic] technology should be [developed locally], the years that dairy's been developing in this country... [Farmer 19]

[robotic milking systems, specifically robotic box systems] It's very barn orientated, that is, the whole problem with this, with all our dairy systems, they've all been devised in Europe, they've all been devised in the States and they've all be devised in barns. [FARMER 20]

Farmers commented on the way prospective new entrants to the industry were trained, and the decision making process in people choosing to milk cows.

We had some people in here, you know every now and then the government puts something in to introduce people to the agriculture industry and they give them a couple of days course at TAFE and then they send them out to a farm for a couple of weeks. [FARMER 29]

If you cannot get a job at McCain's, go milk cows. [FARMER 11]

Dairying is seen as hard work with little return on money.

And, one of your [husbands] nephews, he wanted some work, or whatever, and he goes down and works at the local shop, [rather than work on the dairy] because he sees it is hard work with not much return on his money. [FARMER 23]

Farmers are unsure how to implement robotics into a grazing dairying system due to the steep learning curve required, and believe there is little industry support on knowledge to assist.

Robots were an option, but again it would have stretched me financially and because it is all new technology, I didn't want to be a guinea pig. I would have been under the pump financially plus I would have had a lot of new stuff to deal with. [FARMER 30]

[Industry support for research into using robotics in a grazing system] Not really for robots. We had to work out a lot of things ourselves. [FARMER 29]

4.6.3 Information seeking

The theme INFORMATION SEEKING incorporates all decision-making processes.

This includes all influences, whether face-face with other farmers, family members, industry members, or through field days, extension activities, or organised trips. Relationships with local agents and brand loyalty may also influence decisions.

... Most of your machines are the same, but the people who back them aren't so we usually try to, if we can find good service and sales people we usually try to stick with them. As long as the equipment is reasonable.
[FARMER 23]

The information seeking may be Australian based, or internationally via organised personal or industry trips, or Internet searches and e-mails for information. This has enabled technology to be sourced internationally when unique products have been found.

[Bought a GPS Sprinkler locator] ... Guys at Lincoln Uni [New Zealand] talked about it and we went to the field day on the South Island, and got contact details... [FARMER 6]

The use of ICT for information seeking has changed the way isolated farmers buy products, enabling an independent approach with less reliance on local agents and more self-directed research.

... Time saving, I mean you can do half your homework here rather than running into town. You can make your decisions here and settle business in town if you want... [FARMER 4]

... Saw an advertisement, then got on the Internet and found them, and Dad's over there (New Zealand) now and has bought one. [FARMER 25]

4.6.4 Lacking driver

The theme LACKING DRIVER represents the 'there is just no reason to' concept. Farmers are open to use of ICT on-farm such as in the milking shed but see no benefit or need currently. For example the use of ICT does not fit in with current management needs, or alternatively there may be other priorities.

... You just go on and do what you have always done, unless you are compelled to change, or impelled to change.... I suppose you consider it is not really broke... [FARMER 24]

The belief that 'there is no need' to use ICT may be due to the way the farm is currently setup.

I can see them all [pivots] from the main road, it is not as if I go away and I don't find it for a week if it gets bogged... [FARMER 23]

The lack of a perceived need for ICT can also reflect that there are other priorities currently.

I realise that I'm going to have to learn – get on the computer and learn it, but I'm not fazed by that, I mean if I have to learn it I'll learn it – that's no drama, but I don't need to at this stage... [FARMER 16]

Indeed given the right incentive, ICT use does increase.

...I never used to e-mail much, I have just started as chair of a conference this year, so I have usually got half a dozen e-mails sitting there each night, which I'm not used to, but I am getting used to. [FARMER 23]

The use of ICT may also cease or decrease if the ICT broke and it was not considered beneficial enough to replace.

"We did use tensionimeters for a while, but it's more just feel now... We broke them in the end... They probably did help to get our eye in..." [FARMER 15]

4.6.5 Convergence

The theme CONVERGENCE represents how the mobile phone is becoming the place from which the farmer runs the farm.

... I rarely sit [down] at a computer now, I literally [only] do my accounts... It is convenient - I can sit here, have my coffee and read the emails (on the smartphone). If I need to reply I can do that on the phone [as well]. [FARMER 8]

... I can check emails and Internet - anytime I want to, anywhere. If I've got a spare minute while waiting for the cows to come to the dairy, I'll scan the Internet and see what's going on... [FARMER 8]

It has also changed the way that business is done, and the hours in which business is conducted. Business can now be done during normal 'work' hours, without having make or receive work related phone calls at night.

“ I tend to do all my phone calls while I’m a work now, and at night time I can come home and sit down and don’t have to worry about the phone ringing” [FARMER 3]

Smartphones with increasing screen size becoming more useful.

... I could [get e-mails on last phone], but didn’t. The screen was too small to see them properly, there’s a bigger screen on the iPhones, something you can read. [FARMER 8]

Farmers may have a problem reading text messages due to the small screen size on mobiles. If mobile phone reception is a problem, text messages are better than trying to make phone calls because it does not matter if the phone loses reception and cuts out like on a call because with a text message the message gets sent when in range.

... everytime I get a text on it now, I have got to get my glasses out because I cannot see it. Sometimes it is in small writing, you have got a job to see it and if haven’t got a decent light or anything like that. If something comes on it and it is a lot easier to ring it back or, or let them ring you. But then if you are dropping out all the time you don’t always. [FARMER 26]

Reception reliability influences decisions.

Even now we talk about the point of having a home phone, because really, it is cheaper for you to call on your mobile, with all of the plans and caps and everything, I use my mobile because it is cheaper to ring on that than the home phone, but because of sometimes reception issues, that is probably the only reason why we have the home phone. [FARMER 23]

[Farmer would like to control of irrigators by mobile phone, but due to reception cannot]...because what’s the point? You cannot get any reception [mobile] at the moment. [FARMER 22]

4.6.6 Connected

The theme CONNECTED encompasses everything to do with being ‘online’, which includes the use of a computer.

Internet connections - ADSL and Wireless are preferred over Satellite due to speed. However Satellite is also considered much better than dialup.

Dial-up, it was hopeless. It took forever [FARMER 26]

[satellite speed] *Oh, a bit slow. My sister helps me do the bookwork and stuff, and when she comes out she gets really frustrated. But it's better than nothing.* [FARMER 7]

[why the farmer got wireless internet] *We had satellite which was really, really good but it got very, very slow. Before that we had dial up. No this is a lot quicker [on the computer].* [FARMER 4]

There is no [ADSL] broadband service here, we have satellite broadband, and we have just found out that a lot of the systems [for the robotic milking system] we can't run. You would be doing something on the computer and it wouldn't download or it wouldn't send or it wouldn't transfer the information in a timely manner so that it would do it properly, so it would dropout part of the way through. [FARMER 31]

It's ADSL, so it's fairly quick. [FARMER 9]

ADSL, had satellite but the ADSL seems to be better, it is more reliable than satellite. [FARMER 30]

Interest in the NBN is limited due to a 'when we get it, we will believe it' attitude.

I will believe it [being connected to the NBN] when I see it. I haven't taken any notice of it [the NBN] because I think it is so far down the track... [FARMER 28]

Farmers use the Internet for many activities including weather reports due to the accuracy of these, and purchasing products online from sites such as eBay.

He's just discovered e-bay... He brought a fence tester last night.. Got it for \$9 or something... and a camping fridge... That's his baby at the moment, he's discovered eBay. [FARMER 5]

... [Internet weather sites] *they're very accurate now, I utilise them a lot, particularly harvesting time and watering potatoes... TV and Radio were nothing to what you can do with Elders [a weather site accessible on Internet] now.* [FARMER 22]

[What do you use the Internet for?] *Weather – weather mostly...* [FARMER 5]

Computer use is variable amongst farmers. Some farmer will turn the computer on only when they are expecting an email for example, whereas others are online continuously.

...Well I turned it on yesterday for the first time for about a week. I wasn't expecting anything, I hadn't been talking to anyone, to 'I'll e-mail you', so I wasn't in any great rush'. [FARMER 2]

... I pick up e-mails when I want, and weather sites, and market reports. I am not into Facebook or any of that other garbage that is on there. [FARMER 26]

... [Use computer for] accounts, herd records, a good communication tool, budgets, financial and production. It is a pretty handy tool just to communicate with people without having to go and see them or do it manually, so keep in contact pretty well, so that is good. [FARMER 27]

Or the computer may be part of everyday life.

... I take my computer with me to a lot of the places especially because I'm receiving quite a few e-mails on different issues. [FARMER 1]

If access to the Internet is easy, such as on a smartphone, it is easy to spend little pieces of free time surfing the Internet rather than doing something else.

... If you have got a bit of time to cruise the Internet [on a smartphone], instead of something else, you do don't you... [FARMER 23]

Computer use depends on the individual rather than being generational.

... [farmer in 20s] I don't mind computers, I just don't know much about them, which is sort of the biggest thing holding us back. [FARMER 18]

[a wife talking about her husband in his 30s in his presence] ... he doesn't talk to me - he hops on the computer... When the kids go to bed, you are pretty much on the computer aren't you. [FARMER 23]

If there is a reason to use the computer, the computer will be used, so the main factor is priorities. This may be weather, creating or receiving reports, research, e-mails, on-line purchases, or personal reasons.

[Wife talking about her husbands use of the computer]... *he's computer literate and knows how to use it, but he'd rather get on there and research his family history... and he also knows I'm a lot quicker.* [FARMER 17]

[Does not use computer for anything farming related] *I actually sell skin care for women and he [the husband] often gets into that [skin care] site so I can put my order in or see what's going on.* [FARMER 5]

Wireless data allowance limits may restrict the use of wireless Internet (such as for Skype).

... We used to Skype, but it uses up too much of our wireless [allowance] limit... we cannot download videos either. [FARMER 11]

The reasons for farmers obtaining a computer are generally fairly historic now, with the majority of farmers having had a computer for a period of time. The reasons include external expectations such as an outside job expecting familiarity with computers.

[Farmer explaining that the need to use a computer in off-farm work was the reason for their first home computer purchase ten years ago. This computer was used for the farm business]... *I felt like something from the bottom of the pond because I had no idea how to access the pathology results on the computer [at off-farm work], and I thought 'OK', I need to get comfortable with using the computer.* [Farmer 14]

For some farmers, the initial motivator to purchase a computer was when the GST came in due to the fact GST required the farmer to keep better financial records.

... Was a business decision when the GST was coming in. [FARMER 4]

4.7 CHAPTER REFLECTIONS

This chapter has provided an analysis of the data collected from semi-structured interviews of 33 family farming businesses. The data was analysed drawing on the principles of thematic coding guided by open coding. The chapter has presented 32 themes, which were grouped into five clusters in no particular order, which are shown in Figure 4-1.

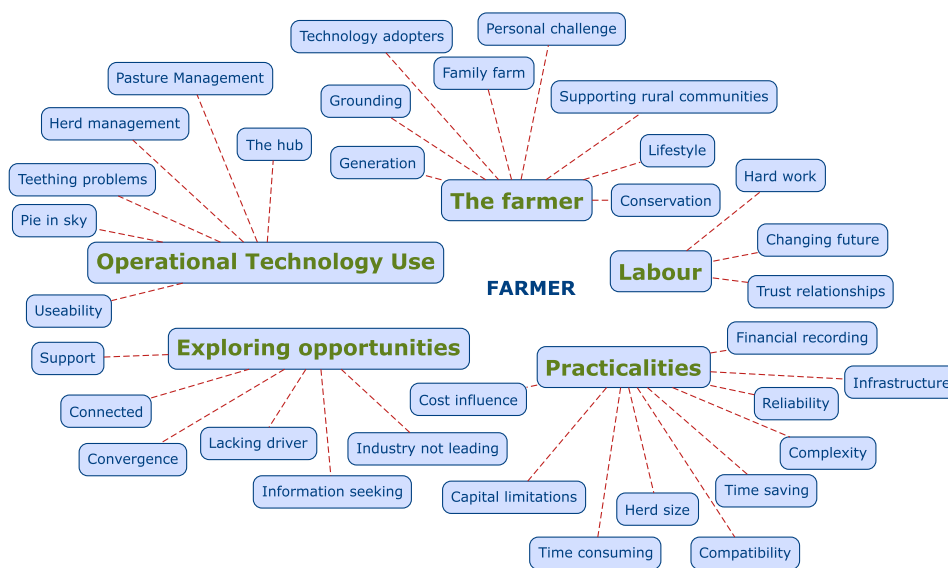


Figure 4-1 Summary of 32 farmer themes grouped into five clusters.

The next chapter provides a detailed analysis of the data obtained from six Industry interviews. The data collected from the Industry interviews provides an alternative lens in recognition that external factors - some of which farmers may not be aware of are important. This facilitate a comprehensive whole, or integrated systems understanding of family farm businesses' use of ICT, and assists in the recognition of the situational context that surrounds farmers use of ICT.

INDUSTRY PERSPECTIVES ON ICT USE

5.1 INTRODUCTION

This second analysis chapter analyses the data from six semi-structured interviews with Australian Dairy Industry service providers, including industry bodies, data processing centres, and software and hardware manufacturers. The demographics of these industry representatives are described in Table 3-3, section 3.6.2.1 (see Appendix 2 for framework of questions). The following chapter (Chapter 6) will provide an integrated interpretation and discussion of the two data analysis chapters.

Industry interviews were conducted, with questions broadly relating to the industry's view on farmers' use of ICT; and industry's perspective on future ICT in the dairy industry. The 27 themes from these industry interviews are grouped into five clusters in no particular order. Extracts from the interviews are provided to validate the development of the theme:

- Section 5.2 provides a detailed description of the themes grouped under the cluster **FINANCIAL**. These themes consider financial benefits of ICT to the farmer, including knowledge, labour saving, and minimisation of human error. The themes discussed are COST BENEFIT and STAFF COST;
- Section 5.3 provides a detailed description of the themes grouped under the cluster **INDUSTRY**. This industry orientated cluster encompasses factors that affect the farmers' use of ICT that are often outside the immediate control of the individual dairy farmer. The themes discussed are DEREGULATION; MISLED; DATA-INFORMATION; EDUCATION-SKILLS; DESIGN-SUPPORT and GREEN;
- Section 5.4 provides a detailed description of the themes grouped under the cluster **LIFESTYLE**. This cluster groups themes which address the farmers' individuality and personal family priorities with the themes ADVOCATE; FUTURISTIC; NEXT GENERATION; MINDSET and LIFESTYLE;

- Section 5.5 provides a detailed description of the themes grouped under the cluster **OPERATIONAL**. This cluster groups themes exploring the operational farm, such as staffing, animals, the collection of cow information, and operational ICT options on the farm. Themes discussed are ANIMALS FIRST; INFORMATION; ROBOTS; STAFF; HERD SIZE; USEABILITY and UNDER UTILISED;
- Section 5.6 provides a detailed description of the themes grouped under the cluster **TECHNOLOGY**. This cluster explores the larger picture: Industry pertinent technological factors, some of which are outside individual farmers' perspectives. The themes discussed are CONVERGENCE; DESIGN; NBN; CONNECTION; TRUST; RELIABILITY and TECHNOLOGY FAILING;
- Section 5.7 provides a summary reflection of the chapter.

The next section describes the cluster FINANCIAL in more detail, providing examples of quotes from interviews conducted during the data collection phase with Industry.

5.2 FINANCIAL

This cluster is cost focused, with the themes COST BENEFIT and STAFF COST considering financial benefits of ICT including knowledge, labour saving, and the minimisation of human error. The theme COST BENEFIT captures the cost benefits associated with ICT use. This includes the cost benefits associated with increased efficiency due to increased knowledge about the farming system, or minimising the costs associated with human error. The theme STAFF COST covers the labour saving cost associated with using ICT. With increasing herd sizes, and hence the need to employ labour, this factor becomes very relevant. Farmers continuously assess the staffing cost associated with progressive ICT such as robotic milkers.

5.2.1 *Cost benefit*

The theme COST BENEFIT captures the cost benefits associated with ICT use. With recent tough times in the dairy industry, farmers have realised that they are running a business not a lifestyle. ICT in the form of shed technology has been put into dairy sheds to increase productivity, efficiency, and minimise costs. ICT allows cows to be individually identified, meaning they can be fed individualised grain rations based on their daily individually recorded milk production. This allows increased feeding of grain to cows that are producing lots of milk, and reduced grain to those who are not producing as much. It also allows the farmer to easily monitor daily milk production of cows individually. This flows

through into efficient farm management by easily being able to identify those cows that are not producing well so they can be sold or dried off². ICT also has a role in minimising the chance of human error in areas such as catching the correct cows for mating, which has a financial cost in lost milk production.

Farmers are realising they are running a business not a lifestyle, and hence need to be more efficient.

...with the tough times, people, farmers started to realize that they were running a business not a lifestyle... So believe it or not that actually helped, it helped their business as much as hindered it, because they wanted to be more efficient and so they were running a business, so if you are drying off cows ad hoc or you are not managing your herds really well, you can lose an awful lot of money by drying cows off too early or too late. [INDUSTRY D]

This has led to more automation equipment being sold in hard times due to the ability to increase efficiency and minimise costs.

Particularly when times are tough, we have sold more equipment in hard times than we do in good times... [INDUSTRY D]

Automation provides the opportunity for improved milk yields and management efficiencies resulting in financial benefits.

...more automation as they struggle 'cause they've really got to get the performance. So the more they can get out of the cow, the better the bottom line is and the more they can control their costs and all this sort of thing. At the end of the day they've got to make a dollar. [INDUSTRY C]

This automation and collection of information allows identification of underperforming cows so they can be sold.

It is all about the information, it really is... they [the farmer] want the information, gone are the days where you can have underperforming cows, these [days] have been gone anyway, now it has become so costly to run the farm, then you want to get rid of those underperforming cows. [INDUSTRY F]

² 'Dried off' refers to when a cow is not milked any more; therefore the cow stops producing milk and the milk 'dries up' – hence the term 'dried off'. Cows producing milk (lactating) have a much higher energy requirement and are fed much better; hence if a cow is being fed well but not producing, it is uneconomical to keep her milking and it is important to identify her so she can be

The ICT system has to be beneficial to the farmer – more than the cost of putting it in or using it. Milk metering (allows individual milk production per milking to be measured and recorded) is expensive to put in, however the benefits are knowledge.

And he [farmer] said “did you have many people interested in milk metering”? And I [industry] said, “oh not too many, because the cost is prohibitive”. And he [farmer] said, “you tell them they have to get it.”... And he [farmer] said, “I do not know how you manage, cows without knowing what they’re doing”. [INDUSTRY D]

Automating certain milking events prevents human errors, which are costly due to lost production. If an individual cow needs to be separated from her herd mates, this is easiest done after milking by being ‘drafted’ out. The reliability of the cow being drafted out when required is particularly important when the farmer is trying to get his cows pregnant as quickly as possible during ‘mating time’. At this time, the cow needs to be separated from the herd reliably after a specific milking so she can be artificially inseminated. Drafting can occur manually with a person physically directing the cow where to go, but she can also be directed into a separate pen using computer controlled gates that recognise individual cows as they go past. The computer method eliminates human error.

...and catching the right cows ‘cause if they’re milking and they want to catch cows and they do not catch them, then they miss a [reproductive] cycle, so they do not get a calf etc etc. And there’s another three weeks [the length of a cows reproductive cycle] production loss. [INDUSTRY D]

5.2.2 Staff cost

The theme STAFF COST covers the labour saving cost associated with using ICT. Farms have traditionally been family farms, and family labour was not necessarily costed. With increasing herd sizes labour needs to be employed, and the cost accounted for. The ‘next generation’ of the family farm takes the cost of labour into account more. Labour is a big factor in choosing to install Robotic milkers.

When discussing whether the cost of labour is taken into account when farmers are costing robots, one industry representative answered:

...Yes, especially it’s getting more and more than it used to be when it was just mum and dad on the farm, labour didn’t count whereas now if they’re paying labour, so the farm is getting bigger so paid labour, that does count and yeah, it’s a different generation out there. They do count their labour nowadays, not all of them do, but... [INDUSTRY C]

An actual example of this saving is given by an industry representative recounting a story of a farmer saving labour costs by installing an automatic drafting gate which negates the need to have a staff member present to manually separate out a cow from her herd mates.

...By having an auto-draft gate, and getting rid of labour, the system, the return on investment was almost immediate because I could eliminate labour, and the costs involved in that. [INDUSTRY D]

Or with certain shed designs where the milker is on the inside of the rotary platform, without auto-draft an extra labour unit needs to be employed for times when a lot of drafting is taking place

...[one] Bloke who put a drafting system in, he's got one of those inside out rotaries, so drafting for him is almost impossible... [INDUSTRY A]

5.3 INDUSTRY

This industry-orientated cluster encompasses factors that are often outside the immediate control of the individual dairy farmer. The themes discussed are DEREGULATION; MISLED; DATA-INFORMATION; EDUCATION-SKILLS; DESIGN-SUPPORT and GREEN. Farmers as well as industry discussed the concepts in the themes DESIGN-SUPPORT and EDUCATION-SKILLS. This is in comparison to the themes DEREGULATION and DATA-INFORMATION, which require an industry good vision, which farmers did not express in their views. Industry good is where there is an aim and vision to do what is best for the industry as a whole, with less focus on the individual farmer needs.

The theme DEREGULATION addresses the issue of deregulation in the dairy industry, and how this industry factor influences farmers' use of ICT. The theme MISLED covers farmers buying a system that ends up not to be able to do what they thought. The DATA-INFORMATION theme covers everything relating to information. This information does not necessarily make it off the farm, relying on the farmer to interpret the wealth of information themselves. Additionally, the effectiveness of the way the industry feeds collected data back to the farmer is commented on. The EDUCATION-SKILLS theme captures all aspects of skills and labour that are required for the dairy industry in the future to progress using ICT. From a skills perspective, there is a generation of dairy farmers who are using ICT (or want to use ICT), but who require a level of agricultural ICT industry

support with basic computer skills. Attracting and retaining staff and the next generation of farm owners is an industry challenge that technology such as Robots has a role in. The DESIGN-SUPPORT theme encapsulates the importance of software design and support in the use of ICT by the farmer. Support is available at the local level ('computer shops' in town), through to phone support, and online support from both within Australia and throughout the world. The cost of this support is substantial to the industry, and this cost drives the development of well-designed systems that can be fixed remotely or by the farmer themselves. The theme GREEN recognises that the industry (milk companies) consider robots to be 'the way of the future' because of their ability to address not only labour issues, but changing generational expectations, and societies developing interest in animal welfare.

5.3.1 Deregulation

The theme DEREGULATION encompasses the issue of deregulation, or long-term 'non-regulation' in the dairy industry, and how this is affecting farmers' use of ICT. Currently industry representatives indicated that any herd or shed management system could be sold to the farmer without the requirement for it to have the capability to send or receive data in the Australian industry standard format or, with other systems the farmer may also have in place. Domestic system designers consider it a priority, and are very conscious of the need for farm-created data such as herd reproductive and milk production data to be readily available to the industry body Australian Dairy Herd Improvement Scheme (ADHIS) for analysis. Hence data flow between farmers and the industry body ADHIS, primarily currently via dairy data processing centres is vital. In contrast, multinational companies, with representatives in Australia place less priority on this.

ICT herd management systems are coming into Australia from other countries.

Well its decentralised, deregulated... And you look at all the automatic systems that are coming in, they're all built in other countries of origin, which may or may not be consistent with our DIF [Australian Industry Standard] files here. [INDUSTRY B]

When discussing use of compatible file formats, international companies may use the international ISO standard, but Australia uses its own format. As discussed by Industry:

But their argument is their data is in an ISO format so an international standard, not just Australian, it's international, except it's not used in Australia which is difficult. Yeah, so that makes life difficult getting data back and forth simply. [INDUSTRY E]

Australia has no rules in regards to what file formats herd management systems need to be able to output data in to provide information to industry bodies such as ADHIS, and in fact whether information has to be provided to industry bodies. There are also no rules as to what is contained in the files.

And look, you know, one of the disadvantages of the Australian system is that there's no rules. One of the advantages of the Australian system is that there's no rules. So you know, it's a bit difficult. [INDUSTRY A]

No rules mean it possible to get a system work for anyone, as there is freedom to implement solutions to satisfy customers.

...and I know how difficult it is for Kiwi farmers, they come out here and say, well how does the numbering system work? You say, well there isn't one. What do you mean there isn't one? Well there isn't, do what you like. What do you mean? Can't do that [whatever you want to do] - do whatever you like. There's blank look on the faces. Heck, you can't do that. So the thing is about recognising what your customer wants and implementing solutions to satisfy that, so we went about implementing a solution to sort that out – to get that system to work in Australia. [INDUSTRY A]

There are many software systems out there, and no standardised rules or software languages.

I think it's a little harder because we have got so many software packages out there too. It's just a little harder to – if we had, I do not know, if we had a standardised system or something that – like it needs to be a little easier to clear with our communication. [INDUSTRY B]

Some farmers do not think about how useful the data they create at every milking could be to the industry, and hence through a flow-on-effect to themselves, or think about whether the data is actually making it to the industry bodies that could utilise the data.

So when you actually sit down with some of these guys and go, you know that by doing what you are doing that none of your mating data is going into the Australian system is being used to enable you to make better genetic decisions for your mating programs. "Oh hadn't thought of that". [INDUSTRY A]

International companies have no need or desire to make the ICT herd management systems compatible with Australia.

...There's about a dozen [different systems]. And I get it from their perspective - why do they have to provide it - they are providing a system

that goes into a dairy that provides that farm with everything they need but unfortunately what we have done in the industry now is create these data islands where the data just lives in this one little place, it goes nowhere else, it does not contribute to the genuine good of the industry and the growth of the genetic breeding systems and all the rest of the things that we could do with that data... I understand it from their perspective... they have bigger fish to fry. [INDUSTRY A]

Manufacturers and designers of domestically produced shed ICT systems have the ability and wish to adapt their systems very quickly to farmers' needs to enable compatibility with other ICT systems that are on a farm as well.

[Farmer using another brand of scales with an internationally designed shed management system]... See any of the local ones would have that ability... because we're not targeting a global market, we generally adapt very quickly. So somebody rings up and wants to use a scale, then really it's not a huge amount of work for us... So, look customers are bringing stuff in from other countries all the time, into Australia and [it – other ICT] is getting used. We have got a system going in up the north-east that's got, with the Waikato D-TECT, which milks each quarter separately and tests the conductivity, mastitis treatment. So we have built in the ability to use that into our system because that gives us another point of sale I guess, or a point of difference. [INDUSTRY D]

And I mean I am passionate about – I think one of the biggest mistakes this industry made was deregulating too far. Deregulation happened in Victoria they just pulled out all the regs [regulations]. So anyone can do anything now, there's no standard for farmers to compare anything to. There are QA standards in other industries. But here you can sell anything you want to anybody and there's just no rules. I think the way it was wasn't perfect either but at least we had somebody that was setting [a] direction and saying... We have been pushing for a long time now for various database projects and what have you to try and get some sort of industry code of practice, if you like, or industry code of ethics, an agreed set of standards, like a 'healthy heart tick' or something like that that says these guys have passed all the tests, and they're okay to sell stuff to you. [INDUSTRY A]

Domestic industry ICT designers would like some rules and standards to be implemented.

It's just frustrating. So yeah, just give us some rules, give us some standards just so that farmers could have [a] degree of surety that this bottom line means it's the minimum level of requirements to talk to the Australian industry, to interact with local data that relates [to each other]. [INDUSTRY A]

5.3.2 Mised

The theme MISLED covers farmers buying a system that ends up not to be able to do what they thought. This issue arises with internationally designed systems primarily. Farmers do

not think to check, or assume that they will still be able to get their information into the Australian databases as required for some industry incentive schemes such as progeny testing programs. International companies do not discuss this with the farmers before purchases of the new system, which is may be a whole new shed with full automation.

Companies do not discuss the issue of whether the farmer wishes their herd information to be able to be shared with ADHIS, but also be compatible with industry-standard measuring systems such as herd testing which the farmer uses directly for farm management decisions, and farmers do not ask.

...Oh, that's the last thing they think of. You know, they've got this high pressure salesman that says, "This will do this, and it will do that," and the last thing they care about is sending the data to a Herd Test Centre, and then when they come to do it, "How do I do this?" "Well, you can't." "Oh, they didn't tell me that"... When they put in a new \$2 million system the last thing they're thinking about is how they're going to get the data between us and them and how it's going to affect their herd testing. I've known some new sheds to be put up but you can't even put a milk meter in it, so you can't herd test physically. That's, yeah, it's crazy but they want to herd test, "Oh, how do we do it? We can't do it anymore." [INDUSTRY E]

There is little reason for international companies to prioritise making their systems easily compatible, as Australia is a small part of their business.

Wisconsin, 50,000 farms, one state. Australia's nothing, so it is, you do feel sorry for the farmers at times because for whatever reason they think important, they'll put in equipment that's not made in Australia and then they'll want it to integrate with Australian systems. And they weren't aware that they were going to have to jump this hurdle at some point and you do feel sorry for them. [INDUSTRY D]

So I think the other problem often is that there are some promises made by the importers that can't be kept or aren't kept. So there are expectations sometimes, particularly with automation systems where the farmer has a completely unrealistic perspective on what they think can possibly happen. You know, I put this automation system in so I can sit on a lounge chair and it does everything for me. [INDUSTRY A]

There needs to be an industry 'code of practice', as a minimum, to protect farmers. This would ensure systems do what is promised to the farmer.

...and get some sort of industry code of practice, if you like, or industry code of ethics, an agreed set of standards... or something like that that says these guys have passed all the tests, and they're okay to sell stuff to you. Because

it can be such a trap. I know of one farming family who spent a very large amount of money building a new dairy featuring a great automation system and a drafting system, it didn't work. It just didn't work. Didn't read the cows, cows didn't draft. It's a lot of money to waste. [INDUSTRY A]

Once the farmer buys the system there is less incentive for the respective company to fix it, particularly an international company where Australia is a small market

...It [the internationally designed system the farmer has purchased] works, you know, the customer has bought it. And I get it. If I am them I am going, ' why am I doing that'? [making the system compatible with local industry systems after the farmer has purchased it, when the Australian market is a small part of their business compared to international interests]. [INDUSTRY A]

5.3.3 Data and information

The theme DATA AND INFORMATION covers everything relating to information. One industry issue is that there is a lot of information sitting on the farm that could be used by the dairy industry for 'industry good' to improve the genetic selection of superior cows and bulls in the future. This information is sitting on farm partly because there is no industry feedback mechanism to create a reason for the farmer to make it a priority to get it off farm, partly because of the 'data islands' that are being created, and have been described in 5.4.1, and partly because farmers are too busy to do something for wider industry benefit – greater industry good without themselves immediately benefiting. The reports farmers get back from herd recording are not necessarily in a format that is useful to the farmer, which does not assist the motivation to provide information that benefits the industry as a whole, which leads to the 'what is the point' view from the farmer. While there is one national database of containing cow information, not all industry members have access to this, or use it, this means the farmer may need to enter the same information multiple times.

Also covered in this data-Information theme is how the industry communicates research online, with this method believed to be more suitable than paper due to the complex nature of the information presented. Also it is interesting to note that despite industry recognising that farmers have slower Internet than those in the city, industry websites are generally graphic intensive.

The industry gets information on about half the Australian cow population through those farms herd recording, which is a standard information pathway. This information goes to Data Processing Centres (DPC's). Herd recording gives volume of milk, fat and protein percentages and Somatic Cell Counts (SCC). This information then goes electronically or via paper back to the farmer, and also electronically to industry. Those farmers who have put in fully automated shed and have opted for milk metering, do not necessarily have to herd test. It is these farmers who have a wealth of information sitting on their farm that could be of benefit to the industry.

We only get data from DPC's [data processing centres], which is herd recording farms, essentially, which is about half of the population [of cows].
[INDUSTRY B]

There are no feedback mechanisms so farmers can realise that their cow information is or isn't getting back into the system.

...they do not really have a feedback mechanism for them to even know if their information is getting into the system. [INDUSTRY B]

Currently information may have to be entered multiple times because systems aren't linked. If the industry went one single database it would negate the requirement for multiple entries by the farmer. For example currently pregnancy test data collected by veterinarians is not put directly into the national cow database, rather the farmer is required to enter the information manually into their herd file, which may or may not be linked nationally.

If they went down the centralised database, those premises that you only enter data once, and right now we enter data lots of different ways.
[INDUSTRY B]

Even with a feedback system in place, there needs to be a better reason than 'industry good' for the farmer to provide information, whether this is a financial incentive or through better targeted useful reports.

I think sometimes we're at risk at looking at the issue of data from our perspective [industry]. That we say, well we want farmers to do this, or how can we convince farmers to enter in their herd test data, for example. And I think that's probably the wrong way around. We probably have to think of it, how does the farmer's life become easier because he's entered that pregnancy test data... do we give them really good reports, for example, that make interpreting the data that he puts in really easy?... There's just

too many things on a farm now to have to cope with that 'Industry Good' stuff is the last on the list. Even for people that have an industry sort of bent really. [INDUSTRY B]

The industry is now communicating its research and providing seminars via the Internet. Concepts may be considered too complex for paper, or it has been recognised as an easy median to use. This allows for little two-minute simple but effective videos to get concepts across, which are much easier to understand.

[On use of videos rather than reading material] ...It's much easier. It's much easier for them to see things than to have to read. Especially 8 o'clock at night and they've been up – you know, you have to think of it through their context as well and we do as an industry send them a lot of reading material. [INDUSTRY B]

Videos allow presentation of complex ideas.

Talking about some really complex stuff that's really hard to do in a simple fact sheet. So they have to be able to use the website which helps you layer information more easily so people can get the summary or they can drill down into the detail, however far they want to go. [INDUSTRY B]

Web-based seminars are used to provide information.

We work a lot also with web based seminars. [INDUSTRY C]

Generally the dairy industry is assuming dairy farmers have the same Internet capabilities as city people.

...Our website is designed for people with slow bandwidth, purposely void of hardly any graphics, so it [the website] can be fast and that's the reason so it [the website] can be fast. But if you look at some of the other websites that are around..., they're all much more graphic and take longer to download. But they haven't worried so much about the low bandwidth... So it's interesting that we're really cognisant of it but we seem to be one of the few that are. No one seems to be worried about it and seem to be able to produce new beaut websites. [INDUSTRY B]

5.3.4 Education and skills

The theme EDUCATION AND SKILLS captures all aspects of skills and labour that are required for the dairy industry in the future to progress using ICT. From a skills perspective, there is a generation of dairy farmers who are using ICT (or want to use ICT), but who

require some level of industry support with basic computer skills. Private industry is providing some of this training but there is a place for public industry support as well to provide the developing area of support for robotic farms. Attracting and retaining staff and the next generation farm owners is an industry challenge that technology such as robots has a role in if promoted.

Farmers are lacking basic computer skills, which the private industry has to provide before the farmers can be taught how to use their specific software.

...No, training really. Support, I mean the support comes after the training. So what we're dealing with in a lot of cases is a customer base, from my perspective as a retailer to this space, that hasn't been equipped with the IT skills to actually drive their computer, let alone the software packages that are on it. So we find a lot of the times that we spend as much time teaching our customers how to use their computer as we do how to use our software... I think if we could up skill the user base then we'd get greater take up. [INDUSTRY A]

Dairy industry bodies do not have the financial resources to provide farmers' with training in basic computer skills.

There's no money in the industry really to provide training for IT. [INDUSTRY A]

The dairying industry is not seen in the education system as being a career that rural kids off farms should be aspiring to.

I know schools in dairy areas that teachers actively promote the line, you know, you've got to study hard so that you do not have to go and work on the farm. [INDUSTRY A]

Attracting and retaining staff and the next generation farm owners is an industry challenge that technology such as Robots has a role in if promoted.

Often it is the family farm that has got the kids looking to come home, and they know they have got to make it more cost efficient and appealing for the younger generation, especially with robotics. They want them home on the farm, you still work the farm, but it is more flexible with robotics, you have still got to put in your hours of work, but you can do it when you need to do it, so if you want to head off and play cricket for the afternoon, you can do it, you can work around it. So we are seeing people in their 60s, put robots in, and then people in their mid-20s going for it, and everything in

between. Usually the younger ones are getting the blessing of their father, and have probably got the financial ability to invest. [INDUSTRY D]

There is a skills shortage as good labour can get better money in other industries. The shortage in labour may be eased by overseas labour.

...the provision of labour in agriculture is going to become a far more complex issue, and I mean some of the policies the government tried to bring, you know, labour in from other countries. I mean those sort of things are going to become more prevalent. Particularly if our unemployment rates stay reasonably low. Because these are jobs that kids these days do not want to do and are being told at an education level that they probably shouldn't want to do them either. So it's pretty difficult to sell that message that it's something they should be doing. [INDUSTRY A]

...Labour is hard to get. They can get good money working in say, so talking Tasmania you are talking in the logging industry and all those other things that are happening in Tasmania... [INDUSTRY C]

A recognition that public and private industry need to work together to learn and hence be able to support the farmer who is using robotics.

We [private company] are in touch with future dairies [industry funded research group], we are very proactive with future dairies, and we will help assist getting future dairies on-site to talk to the farmer, and they have discussion groups, we have discussion groups... so it is all right to train TIA [Tasmanian Institute of Agriculture] staff, but it is not just something you pick up overnight, so he has got to be continual, we need more farmers so those TIA staff can get experience and having one at either end of the state isn't helpful... they [TIA] are going to have to have experience and the knowledge, so the farmer goes "oh, he knows that he is talking about, I will follow and trust him and do what his suggestions are", how do they [TIA staff] get the knowledge and experience, if they are not allowed out on the farm to get the experience. [INDUSTRY F]

5.3.5 Design and support

The theme DESIGN AND SUPPORT encapsulates the importance of software design and support in the use of ICT by the farmer. Support is available at the local level (IT shops in town), through to phone support, and online support from both within Australia and throughout the world. The cost of this support is substantial to the Agricultural ICT industry, and drives well-designed systems that can be fixed remotely or by the farmers themselves.

Local IT shops do not necessarily sell their customers the best solutions. Farmers will continue to support the business until they are shown somewhere better, once shown they may choose not to return.

...they'll go to the same place until they speak to someone like me who says "did you know you could do it this way for half the price", then they stop going to that place all of a sudden. And yeah that's happened a few times, unfortunately for that place. But I do not have much sympathy for those guys because they know. They know that there are more cost effective solutions for their customers but they choose not to do that because maybe there's a more lucrative solution to them. [INDUSTRY A]

Remote access is used to provide easy support and training, including monitoring of what is going on in the system and on the farm.

I reckon we save 50% from our support time than previously with remote access. So what you used to have to do is mentally picture where they were on the screen and where they might have got to, despite your best instructions, and then find a way. You know, so that's painful. I have done stuff on IT for a long time now, it's been 20 years so yeah the last three has been the easiest of all because you can just jump on, say this is what I am doing, this is why I am doing it, if you need to do it again this is how to do it. So you use it as a training opportunity, it's really valuable. [INDUSTRY A]

This remote ability also allows specialist animal health and herd management advice to be provided from anywhere in the world.

They've got all this information on the cows and they can start benchmarking. So a lot of that sort of stuff is starting to happen. They're benchmarking with friends, other robot users, one thing and another. The world becoming a small place so people want to know, how are you going, how do I compare to other people in the industry. So, and this information technology allows them to do this and we are able to get really qualified advice onto the farm remotely by just looking at the key performance indicators like, for example, if you are in the joining period and you find that the submission rate is not good, stuff like that. You can instantly see these things, the system shows it. It's part of the key performance indicators. [INDUSTRY C]

Support (breakdown support) is vital, and a key reason for dissatisfaction and changing of systems. It is also a great expense to the industry and the farmer if the system is not designed right.

...All of our changeovers, most of those are because of support. It's not so much that they're unhappy with the systems, because they do not know any

better. So if you are using a specific system, you do not know any different to that, so you'll assume that all systems do the same thing unless you see somebody else's. [INDUSTRY D]

...And one of the reasons he said they went into receivership was because of after sales support. So things breaking down etc... The biggest problem they had was breakdowns. So we probably, a third of our sales were replacing other systems in automation which is quite extraordinary. [INDUSTRY D]

Design of systems is continuously changing to make systems more intuitive for the farmer to use.

...like we have got a new version coming out, our goal is to, what we do is look at why we're getting support calls and try and eliminate it. So what are people struggling with and how can we make that easier? [INDUSTRY D]

5.3.6 Green

The theme GREEN recognises that the industry (milk companies) consider robots to be 'the way of the future' because of their ability to address not only labour issues, but changing generational expectations, and societies developing interest in animal welfare.

milk factories that are keen to work with us because they want the dairy industry to be sustainable 'cause they see, are the young generation, the next generation going to come in and work as hard as their fathers and grandfathers did? - Possibly not, whereas by using this sort of technology a dairy can be sustainable and it's also friendly to the animal and that's important because there's going to be more requirements from the green side of things that, the cows are treated well and all this sort of stuff so in actual fact they know the cows are really monitored and looked after better using the robotic system than they are in a mass amount of cows going through a dairy. [INDUSTRY C]

5.4 LIFESTYLE

This cluster presents the lifestyle themes influencing the farmer. The cluster groups themes which address the farmers' individuality and personal family priorities with the themes ADVOCATE; FUTURISTIC; NEXT GENERATION; MINDSET and LIFESTYLE. The ADVOCATE theme represents the positive attitude that dairy farmers of all generations have towards the use of ICT in their farming enterprise, including how ICT is used and factors influencing use. The theme FUTURISTIC comprises the perceived future of ICT in the dairy industry, how individual attitudes are important, and how the NBN has the ability to change the way farmers manage their herd whilst out in the paddock. NEXT GENERATION

as a theme captures that the 'Next Generation' has a different idea of work to their parents, and what is 'acceptable'. Lifestyle is very important, and there is an attraction to computers and a more automated environment. The theme MINDSET describes the individual's attitude ('mindset') towards ICT, whether it is a positive or negative perspective. The theme LIFESTYLE looks at how ICT has the ability to improve the attractiveness of dairy farming from a lifestyle perspective, making dairy farming less physically challenging,

5.4.1 Advocate

The theme ADVOCATE represents the positive attitude that dairy farmers of all generations have towards the use of ICT in their farming enterprise and how this attitude influences their use. It includes how ICT is being used and any influences to ICT use.

Cameras are used in robotic dairies to allow remote viewing of cow activity – through the initiation of farmers, as the cameras are not supplied by robotic milker manufactures.

[on use of cameras] ...yes they do, we do not actually supply them, but they are all doing it, it is weird, but anyway, and these cameras are unbelievable, they can go down the lane, and zoom in on the cow down the lane. But that is, it really is [it], they [the farmer] can interact, we [industry supplying and supporting robotic installations] have got access, we can login and see what is happening, not just the reports and the results and self-tests, we can actually physically see what is going on [because of the cameras]. [INDUSTRY F]

Automation on farm is considered inevitable by the industry.

Even if the country gets down to 4,000 farms, we expect that all 4,000 farms will have automation. It's inevitable. [INDUSTRY D]

The installation of Robots is undertaken by all generations of dairy farmer.

...often it is the family farm that has got the kids looking to come home, and they know they have got to make it more cost efficient and appealing for the younger generation, especially with robotics. They want them home on the farm, you still work the farm, but it is more flexible with robotics, you have still got to put in your hours of work, but you can do it when you need to do it, so if you want to head off and play cricket for the afternoon, you can do it, you can work around it. So we are seeing people in their 60s, put robots in, and then people in their mid-20s going for it, and everything in between. Usually the younger ones are getting the blessing of their father, and have probably got the financial ability to invest. [INDUSTRY F]

The rate of ICT investment on-farm may depend on whether parents have continued financial control over the farm.

And we're seeing as generational change is taking place, probably increasing frequency over the last half a dozen years, we're starting to see more and more – you know, the younger people pick up technology and they'll run with it. To varying degrees. And again, with that generational change it depends on how tight the parents hold is still on the farm as to whether some of these things happen. [INDUSTRY A]

Robots have the ability to attract a different level of staff into the industry – staff that are ICT literate and enjoy interacting with ICT.

...you actually attract people at a different level 'cause they really want to sit there and see how the cow performs and see how much milk we can get, see how, if I do this, if I change their ration, this is the difference it makes. So it really does attract different type of people. It does make a difference. [INDUSTRY C]

The farmer's kids will drive the uptake of high speed Internet by the farmer. Once the high-speed Internet is installed, industry believe farmers will notice that their Internet is faster which will lead to the farmer realising more can be done using ICT at faster speeds.

The kids will drive the parents' uptake of high speed Internet, because of their demands... Chinese water torture, another drip, another drip, and another drip and eventually you fall over... And then you discover things that you didn't realise you could do. Oh wow, it can do that. [INDUSTRY A]

Robotic milking systems are being used by the older farmer as a way to keep farming as the body breaks down.

...older people that don't want to give up dairying but the body's breaking down a bit. They're saying, "that's for me because I can keep going on but I don't want to give up just yet, however over the years my back's got bad", and all this sort of stuff. So they see an advantage then, that they can continue doing what they love doing without the hard labour... [INDUSTRY C]

5.4.2 Futuristic

The theme FUTURISTIC composes the perceived future of ICT in the dairy industry from the perspective of the agricultural industry.

The right attitude is important when changing to a robotic milking system.

...[robotic Rotary] that is right, they will make it work. And he's [the farmer putting the robotic milking system in] got great attitude, which is very... They had to be the right, it is a test farm, pilot farm, it is the first commercial AMR in the world basically, so it is exciting. With the box robots, we now know how it works, and all of that. The AMR, is still, the technology again will milk the cows, but how do we get the cows there, how do we get that flow of cows. High production cows, low production cows, once a day cows, when you talk to a farmer who is looking at it, and has got his head around what he wants to do with it, next year, or a year later, he has got part of his cows that he wants to milk once a day, and the rest he wants [to milk] twice a day, so he will run two herds, he will properly voluntary milk goes, and batch milk these ones. There are lots of options. It is very interesting, and not one farmer is the same. [INDUSTRY F]

When considering future ICT developments or advancements for the dairy industry, representatives of the agricultural industry are of the opinion that future NBN infrastructure will create many opportunities.

Got a few farms that have got infrared cameras mounted in the calving sheds so that they can get up in the middle of the night... Yep, it's great. It's fantastic technology. But think about that at the moment, the way that that's typically managed from an IT perspective is that you've got to have the wireless networks and you've got to have the speed. So think about, well okay, we're all running off the cloud so we just see how this paddock, you know, five kms, where all of a sudden those things that were difficult before and cost prohibitive will become a lot more easy to do. So that's why I am passionate about the NBN, it will just create so much opportunity. [INDUSTRY A]

Industry believes infrastructure will be in place within the next ten years that will enable dairies to have Internet access. This will enable agricultural companies to design systems that will utilise this infrastructure. The Agricultural Industry sees the challenge then to be designing products that will encourage farmers to utilise this infrastructure.

I think the industry's going to change again. The next 20 years we'll see some massive changes and the Internet will become part of that. And the next ten years, like you'll have, all dairies I believe will have Internet because systems like ours and all that sort of stuff, will be able to utilise it, if they get it and people I guess... We'll need to make products that encourage them to

get the Internet on there. But most dairies you can get mobile reception at now. Most. There's very few automation systems that we have put in where there isn't mobile reception at the dairy. Some of it's a bit patchy, but it's there. Tassie's [Tasmania is] probably actually one of the worst you know.
[INDUSTRY D]

5.4.3 Next generation

The theme NEXT GENERATION encompasses the view that the next generation has a different idea of work to their parents. This generation also differs to their parents in regards to what is considered acceptable work. Lifestyle is very important, and there is an attraction to computers and a more automated environment.

...a big impact that robotic milking has is, I guess, it starts with things like lifestyle because a lot of these farmers, their sons are taking over from the fathers and they actually want to spend time with their families. So it's very, very important to them that they now can, that they can have the ability to spend time with their kids, go to footy matches and do whatever they do. Robotic milking does allow them to do that because you're not tied down to milking twice a day. I mean we just have to accept that the generation X and Y is not entering the workforce [dairy industry]. Like for my parents, it was totally acceptable to work seven days a week and work long hours. Today it's not that easy anymore is it? The younger guys, younger folks that want to spend time with their family, they're looking after family time and there's also the expectation that things should be easier not hard, not physical. Things are done on computers. ... so we see now with the farms where we implement the robotic milking systems that that makes a difference. The worker is going away from the physical work to a more automated environment... [INDUSTRY C]

5.4.4 Mindset

The theme MINDSET describes the industries assessment of individual farmer's attitude ('mindset') towards ICT.

A positive attitude by the farmer towards the utilisation of newly installed ICT in the shed is influential in the overall success of the adoption.

...They certainly know a lot more about it in the last couple of years. They do their research online. The guys that are really, and they are the ones you really want, to take your system up, because you know they are going to use it, and you get a real sense of achievement, I know I do, where they put it in, and they actually use it and get results, and they have done their work online and checked everything out, and then, they need the support structure behind it, so they hopefully go our way, [the farmer chooses our

company to do business with] *but they are the ones you want, I reckon.*
[INDUSTRY F]

The successful use of robotic calf feeders depends on the individual farmer. Some farmers pull them out, and others install more.

...we have got people who do put them on, and they go “ Oh shit, it is not working how I thought it was going to work”, and they pull them out, and there is always someone who is going to buy them. And some have got a dozen, and they get more and more of them, because they go “well hang on, this is the only way to rear calves”, so it is horses for courses. [INDUSTRY F]

5.4.5 Lifestyle

The theme LIFESTYLE encompasses how ICT influences the lifestyle of the farmer. This is generally related to making the farming job less physically demanding, or improving time management on the farm, allowing for more non-farming related activities which influences the farmer’s perception of an improved lifestyle.

Robotic Calf feeders are attractive to females because they are less physically demanding than manually handling calves.

A lot of the ladies do look after the calves still. And they really like the calf feeders, because it is not as physically demanding to handle the calves and the milk. [INDUSTRY F]

Robotic milkers give the farmer a better lifestyle through removing the necessity to milk cows every day.

It allows the farmer time to manage his farm rather than just do manual stuff. It gives him a lifestyle and it takes away that drudgery of, “I have to be there at such and such a time”. [INDUSTRY C]

As farmers automate the milking process, they will have more time for activities like using the Internet.

... I think in a nutshell, farmers seem to be, one of the big problems that they face is they’re too busy to, they always say they’re too busy to do anything. But as time goes by they’ll automate, which will give them more time, which means that the Internet will then [be used], they’ve all got Internet, they might not be using [it] at the moment. [INDUSTRY D]

5.5 OPERATIONAL

This cluster groups themes which explore the operational farm, such as staffing, animals, the collection of cow information, and operational ICT options on the farm. Specifically, the seven themes discussed are represented as ANIMALS FIRST; INFORMATION; ROBOTS; STAFF; HERD SIZE; USEABILITY and UNDER UTILISED. The theme ANIMALS FIRST encapsulates the 'Animals First' priority. 'Animals first' is generally associated with Robots due to the opportunity for individual cow treatment, which gets lost as herd sizes get larger and the farmer does not necessarily know every cow, or does not have to time to spend with each individual one. The theme INFORMATION captures how the key to farmers continuing to use systems is data entry. Automation systems assist in this process because data is easily maintained at the shed. The Internet is being used not only for online research, but the beginnings of global comparisons of KPIs by robotic farmers and for global herd management support. The ROBOT theme explores Robot concepts. Robotic milkers require some specific skillsets when changing to this system. The difficulty of changing systems is emphasised to farmers, as is the need for the farmer to be responsible for pasture management with this being outside the robot manufactures skillset. STAFF as a theme encapsulates staffing considerations and factors. Staff may be treated very differently between farms. The main categories relate to staff quality and quantity, and whether staff are trusted and valued or not. Staff not being fostered came through strongly by one industry contact, indicating the industry's labour problems relate directly back to not fostering and encouraging staff. The theme HERD SIZE describes herd size considerations. Herd software is used by farmers of any herd size but automation is put in by farmers with larger herd sizes, or increasing herd size, to manage the paperwork. USABILITY as a theme follows how systems and features that are easy to use and how the provision of ICT support to the farmer influences the ongoing and final use of a system. The theme UNDER UTILISATION captures the under utilisation of installed ICT.

5.5.1 *Animals first*

The theme ANIMALS FIRST encapsulates the 'Animals First' priority. 'Animals first' generally is associated with Robots due to individual cow treatment, which gets lost as herd sizes get larger and the farmer does not necessarily know every cow, or does not have to time to spend with each individual one.

[Robots]... *the system has to be designed around cows and calves because at the end of the day that's what we're dealing with...* [INDUSTRY C]

Robotic calf feeders are put in so more time can be spent with the calves rather than feeding them.

... the good calf rearing setups, they do spend time with their calves, and they have put the calf feeders in for various reasons, and one of them is not so much to save time, but so that they can actually look after the calves instead of trying to feed the calf... [INDUSTRY F]

An industry representative reflected that cows milked by robots are very quiet, content and much safer to be around.

... at least if the cows are quiet, the kids are safe around them... The cows just stand everywhere looking at you, everywhere, from the shed, to the paddock, the cows [are] standing there doing their own thing... [INDUSTRY F]

Milk suppliers can see sustainability benefits associated with robotic milking systems, and are interested in working with the respective farmers.

We have got milk factories that are keen to work with us because they want the dairy industry to be sustainable. It's [robotics] also friendly to the animal and that's important because there's going to be more impediments from the green side of things that - the cows are treated well and all this sort of stuff. So in actual fact they know the cows are really monitored and looked after better using the robotic system than they are in a mass amount of cows going through a dairy. [INDUSTRY C]

5.5.2 Information

The theme INFORMATION encompasses information management on the farm. The key to farmers continuing to use systems is the ease that the large amount of data generated from the milking shed, or other activities gets entered. Automation systems assist in this process because data is easily maintained at the shed. The Internet is being used not only for online research, but the beginnings of global comparisons of KPI's by robotic farmers and for global herd management support.

As software systems are getting easier to use, the stereotypical 'wife does the data entry' is incorrect, and more men are doing the data.

...What I used to find back when I was with (x), and their package was a lot more difficult to use, it was generally the wives who were doing the data entry and the husbands were you know, out doing stuff. We find now with our software, more men are doing the data. 'Cause I mean there's still the stereotypical, you know the wife does the data entry, but we're finding that we have got a lot more of the guys actually do all the figures and that... [INDUSTRY D]

Dairies that are fully automated, and hence require cow data to be up-to-date for the cow to be milked make it easier for the farmer to manage data entry requirements because it is not possible to accumulate data that needs to be entered 'at a later date'.

Automation system will manage that for them because it's got more information and it sits in the shed. Maintaining it becomes more of an imperative and it's on the site. So because all the cows will go through the shed, if three cows didn't show up, that would be them. And so they can just double tap on that cow and dry her off on the spot or sell her or kill her whatever, instead of, six months down the track going, oh where's that list that I wrote down from six months ago of those 10 cows that I sold or whatever? [INDUSTRY D]

If a farmer gets too far behind in data entry they can stop using a herd management package.

If somebody stops using the software, it's because they got too busy and stopped putting the data in and then suddenly they were six months behind and it became a, oh I've got to get that done. It's such a big job if they do not get to it. We do find that. [INDUSTRY D]

Keeping data up to date in herd management software is a problem.

It is not just getting information in, it is keeping information up to date, keeping that breeding pattern happening so you know when she is going to calve, because that is the whole idea, to be able to draft the cows that are drying off, and check you know, once the milk gets down low enough, what is the point of feeding her when she is only producing five litres, when she has done 300 days lactation, well get her out of there, get some condition on her, and those sort of things. A lot of farmers think it is just going to happen, we loaded [the software] for them, and it is going to work, they just do not keep it up-to-date. Shit in, shit out. [INDUSTRY F]

Global links are allowing farmers to compare what they are doing with other farmers throughout the world, and get international advice on key performance indicators to do with their herd.

They're benchmarking with friends, other robot users, one thing and another. The world becoming a small place so people want to know, how you are going, how do I compare to other people in the industry. So, and this information technology allows them to do this and we are able to get really qualified advice onto the farm remotely by just looking at the key performance indicators like, for example, if you are in the joining period and you find that the submission rate is not good, stuff like that. You can instantly see these things, the system shows it. It's part of the key performance indicators. [INDUSTRY C]

Automation systems may initially just be put in to supply information to the person putting cups on the cows.

...if they just want labour putting cups on, then they put the system in, not because they want the labour to operate it, they'll operate it, but they want whoever's putting the cups on to be informed as to what's going on...[INDUSTRY D]

Industry is having mixed success with online support mediums. Forums on websites are not well utilised, however YouTube may be effective.

We just put our first You Tube video up this week and we'll probably start to utilise that more. We did have a forum on our website and when we changed systems we took it down because it wasn't being used. It had a few people, you'd only get a small number of people who would use it and because there was nothing, no new people coming in and stuff like that, so it really wasn't getting used. [INDUSTRY D]

A bad experience with ICT influences not only whether the farmer will try another system, but might also influence their peers.

That's exactly the way it works. Down the saleyards and "oh how's that new thing you got?" "It's bloody rubbish". So all of a sudden there's a warning bell in that guy's head. [INDUSTRY A]

Similarly positive software use experiences are communicated through the same social networks with increased sales and hence adoption an outcome.

...a lot of our sales come through word of mouth. Last time we surveyed it was round 70% of our sales come through word of mouth which was quite extraordinary, so they're talking to their neighbours. [INDUSTRY D]

Farmers are utilising the Internet to research their individual requirements for ICT. However not all farmers have access to fast Internet.

We also experience that our work has changed in the last three or four years because the farmers are more educated through their Internet research that

they've been doing. So you feel that farmers have been searching the Internet. They open up YouTube and all these sort of things where you also can collect a fair bit of information but it's still an issue for us because not everybody really has good access to reliably fast Internet. [INDUSTRY C]

Online research is allowing those people who do not trust sales people to easily do their own research.

...there are some people that do not trust, just innately do not trust advisors because they are trying to sell them something. And so they will be more independent researchers and then they'll just come back looking for the best deal. [INDUSTRY A]

Robots create a large amount of data that needs to be interpreted quickly and accurately. Software that enables this places a high emphasis on presenting information visually. The priority of the software designers is to save the farmer time.

...Yes, very visual and you can scan it and have it rather than spend half your life looking at the computer because what we are trying to do is free up their time... [INDUSTRY C]

5.5.3 Robots

The theme ROBOTS encompasses specific Robot milking system ICT issues. Robotic milkers require some specific skillsets when changing to this system. The actual changing of milking systems to robotics requires teaching the cows to accept a new way of being milked, and the development of pasture management to a whole new level. This new pasture management skillset is required because the cows are motivated to voluntarily present themselves to be milked through the robotics by the enticement of fresh pasture after being milked. This is in comparison to the cows being physically moved from paddock to paddock under traditional milking systems.

Farmers are warned by robotic system manufacturers that changing systems is going to initially be very difficult, and that this is likely to place significant emotional strain on the whole family.

We try and tell them the worst case scenario, and how hard it is going to be to start up. You know, you can have sleepless nights for weeks and weeks on end, training these cows, you've got to get that pasture management right, you've got to stretch out their milking, you've got to break the herd mentality habit, it is - tricks of the trade. [INDUSTRY F]

Managing pasture in a robot system is very different, and requires a skillset that hasn't ever been needed to that level before, creating more stress.

We certainly outline it very heavily, that the robots will milk the cows, we can control, if you get the cows into this area, we will milk them, and send them back to different paddocks, you have got to manage the pasture, or a feed pad. They all go yeah, yeah, yeah, I am a good pasture manager, and then they go "O shit", I haven't got cows travelling, what is going on, so we certainly make it very clear that they have to manage that pasture very very clearly. [INDUSTRY F]

5.5.4 Staff

The theme STAFF encompasses all factors relating to the employment of staff by the farmer. How staff are treated, respected, and valued varies very differently between farms with some farms having no problems finding staff, and other farms having significant problems. The main categories that came up related to staff quality and quantity, and whether the staff were trusted and valued or not. Staff not being fostered came through strongly by one industry contact who commented that the industry's labour problems relate directly back to not fostering and encouraging staff.

Industry was critical of farmers' lack of interest in creating a challenging and rewarding work environment for their staff, and believed this was the reason for the staffing problems in the dairy industry.

Getting good farm labour is hard and I unfortunately blame the farmers for that. Any other business would employ somebody and involve them, a good business to work for is somebody who makes employees part of the business... And I think farming should be the same... If somebody wants to work on the farm, if you get them and stick them in the shed twice a day and sent them out fencing or whatever and don't give them anything to stimulate their minds, they're not going to last that long. So I think the farmers should be involving their staff in the technology, in the herd management, get them interested in cows. 'Cause hopefully a lot of these people, there's a reason why they've decided to go onto the farm in the first place and it's not just because it was their last choice'. [INDUSTRY D]

Poor quality of labour is seen by industry as a reason for farmers putting in ICT-enabled milking sheds.

I think [the] majority of the farmers that we see putting automation systems in, it's about labour. So it's about either not having access to good labour or

wanting to save money on labour units if they can. And I think that first one is probably more prevalent. You know, a lot of farmers get burnt with poor standard of labour. So you know, they look for solutions around how are we, you know, what have we got that can help us with that. [INDUSTRY A]

Industry identified some farms where the employees are encouraged to interact with the ICT-enabled dairy shed. The employee described below manages the electronic data entry for the farm owner.

There are some farms where they have got some really good young staff who are quite techno-savvy, and they will actually do all of the, 'the farmer will go "I want to feed those cows such and such", okay, the young kid comes in and does it for him. [INDUSTRY F]

5.5.5 Herd size

The theme HERD SIZE encompasses the incentive larger herd farmers have to use ICT. Herd software is used by farmers of any herd size. Automation is put in by farmers with larger herd sizes or increasing herd size, to manage the paperwork.

Now this is on automation, that's a range. On herd software, herd size doesn't really matter. But on the automation, no, there's no, oh we'd probably put it into more farms that are milking more than 200 cows I guess. [INDUSTRY D]

I guess as their numbers are going up, they're looking for an easier way ... I think just to try and eliminate the paperwork. Like, and to manage things better. [INDUSTRY D]

5.5.6 Useability

The theme USEABILITY encompasses the useability of the ICT once installation occurs. The USEABILITY theme of ICT includes support options for industry once the ICT is installed on the farm.

If a farmer buys a milking system containing significant automation, the farmer may end up using the ICT in the new milking system for more than initially intended as the farmer 'grows into' it.

You'll find that once they've got it they start to expand out, what they originally wanted it for anyway. [INDUSTRY D]

Industry observed that farmers are choosing to put a fully automated system in by default, whereas a couple of years ago, installation of a basic milking system was more common.

A couple of years ago, it would be a basic system, I want to grow into the system. Now it is just put the whole lot in. [INDUSTRY D]

Improved options for remote access support by industry occur because of enhanced useability of farmer systems.

[X herd management program], we can take over their computers now and help them solve problems or show them how to use things with the program. In the dairy, the IT system is a lot simpler because you don't need all the reporting or stuff like that. So touch screens, big buttons, so we can talk people through things. [INDUSTRY D]

5.5.7 Under utilised

The theme UNDER UTILISED encompasses that some farmers insist on putting in a fully automated system, but then do not use the new system despite industry help to import the necessary data, and set the system up.

We have got farmers out there who have put in everything milk metres, conductivity meters, draft gates, weigh scales, everything, cup removers, and never use it, just use it as a basic dairy with cup removers... some of them just don't, they want to, but they are not interested in turning it on and using it - it is unbelievable, it would have cost that milking system. If you try and just sell them a cup remover, they go "no, I want everything", and you go, 'righto". [INDUSTRY F]

5.6 TECHNOLOGY

This cluster explores 'big picture' industry relevant technological factors that are largely outside individual farmers' perspectives. The themes discussed are CONVERGENCE; DESIGN; NBN; CONNECTION; TRUST; RELIABILITY and TECHNOLOGY FAILING. The theme CONVERGENCE relates to the use and perceived future use of all hand held devices, whether it is a mobile phone or 'palm', because the terms 'hand held', 'Palm' and 'smartphone' are used interchangeably in interviews. The DESIGN theme explores design considerations by industry, such as 'user centred', and research and design priorities. Due to the anticipated significant effect the NBN will have on rural communities, the theme

NBN is separate to the theme CONNECTION. NBN as a theme captures industry perceived use and hence design potential of the NBN, with every company having a positive outlook on the future of the NBN, projecting industry uses in the near future. The theme CONNECTION covers Internet connection, including Internet options for farmers, and how satisfactory (or limiting) the industry considers farmers current Internet options to be. TRUST as a theme represents industry perception that a significant proportion of farmers are still writing information down on paper before transferring it into the computer. The theme RELIABILITY captures how reliability (particularly automation or robot milking systems) is vital for customer satisfaction, and is hence an important system design consideration for ICT companies. The theme TECHNOLOGY FAILING explores the release of ICT onto the farm before it is fully tested, or 'bomb proof' in pasture based systems and how this influences the resulting farmer experience.

5.6.1 Convergence

The theme CONVERGENCE relates to all hand held devices, whether it is a mobile phone or 'palm', because the terms 'hand held', 'Palm' and 'smartphone' are used interchangeably in interviews. Industry representatives consider Australia to be leading the world in the use of apps on smartphones with herd management software and automation. Industry does not consider durability to be an issue, taking a more philosophical 'Farmers will only break them a couple of times before they change how they use them....' The development of smartphone apps is being pushed forward by farmers as it is considered a more accurate and accepted way getting data entered by all farming generations.

Smartphone apps are being demanded by farmers.

We have got a pretty large groundswell of people that are knocking on the door saying "please give us an iPhone app". [INDUSTRY A]

Australian agricultural ICT developers consider themselves equal or ahead of the world in the provision of apps to farmers for entering and managing herd data, integration with herd management systems and automated dairies.

...look at the farmer developments and clearly we have done a bit of research on hand held stuff and we think we're probably ahead of the game as far as the rest of the world's concerned, on development of the iPhone and Android apps. It is difficult to get a line on anyone else because there isn't much else out there. [INDUSTRY A]

Durability with handhelds is not considered a big problem by the industry, with industry taking the philosophical approach that the farmer will only break one once or twice before they start changing the way they do things.

...Three or four that have smashed palm pilots and that's out of a hundred or so. So yeah, it will happen but you know, unless you are really stupid you probably only smash a thousand dollar phone a couple of times and then you change what you do. [INDUSTRY A]

Hand held devices improve data accuracy by enabling data entry at the time the data is collected.

...It's 90+ percentage of farms and how it works. And then the wife sits there and she types the first one and she looks and she can't read that, so she yells out "what's this on the second line?" So he comes over. That can happen, depending on how strong their relationship is, three to five queries out of that list of stuff and after the fifth query he snaps and she does not ask anymore. So she guesses... This is the way it works. I am not making it up. I wish I was making it up but it's exactly the way it works. So we spend a lot of time working on developing hand held solutions so that we took out that step. So what we're trying to do is develop systems where the collection of data happens where the data is collected. [INDUSTRY A]

All generations are using handhelds, and farmers prefer handhelds. The agricultural ICT industry has found that farmers who are hesitant or who will not use desktop computers, are more receptive to, and indeed 'love' their handheld devices.

I get 60 year olds using this. And people that you wouldn't expect. You know, one of our board members is just an amazing proponent, retired in his mid-fifties I think and hopeless on computers - hopeless. You know, completely – loves this. He says, "I will not sit in front of the computer but I love my palm". So there's a real acceptance of that technology. You know, if someone does not like sitting in front of a computer, does not matter how enticing you make the software, you are still asking them to use something that they do not like doing. [INDUSTRY A]

The beauty about the handhelds are they actually, what we found is there's less, we reckon there's less of a fear factor with the hand held than there is with a computer. ... I think it's about the fact that they see it a bit like the phone and they're sort of used to their phone. They might not love it but they still get used to it, they've worked out how to text by now, so got that bit down. You know, the buttons are pretty easy to follow. Oh okay, we have calved, I will press this. So you know, we found that, and look we have got plenty of farmers that have got a computer and they've got this and they'll come home and they'll sit in the lounge chair and they'll data input on this rather than walk over to the computer. [INDUSTRY A]

Industry is projecting that the smartphone will be used in the future to access cow information in the paddock. This information will be acquired via the 'cloud', which will synchronise with the milking shed data.

...if you are down the paddock you can just punch a draft straight into your phone and that cow can be drafted [at a selected milking], things like that. That is where it is heading, to be able to walk into the paddock or you know, get all the cows that are on heat. ... the farmer will be able to look on the Smartphone and see how many cows he's got on heat at any time of the day. [INDUSTRY D]

5.6.2 Design

The theme DESIGN incorporates industry system design considerations. Internet is not a big factor in design of domestic automaton systems currently as it is fairly unreliable in rural Tasmania. Internet is not available at the shed, but is at home. In the future there will be Internet at the dairy, which will open many possibilities. Research and development (R&D) is considered to be very important by the industry.

...So the Internet at this stage isn't a major factor for us because it's a bit dodgy in a lot of rural areas, but we find that most farms have got Internet at home. Not at the dairy. So it will become a factor and we'll be able to use it more and more which is great. It allows us to, you know do really cool stuff... [INDUSTRY D]

Industry value R&D, and utilise interactions with farmers to continue to improve systems.

...We, everybody in the business is involved in research and development. We all love it. We get ideas from the farmers, from ourselves, all that sort of stuff on how we can improve this. And we do, we always look for better ways for doing everything, inside the business and for others... Research and development is the key... incredibly import, because the others [companies who have not been successful] didn't keep going. They got a product and started selling that product and didn't keep moving forward. [INDUSTRY D]

5.6.3 NBN

The theme NBN captures the positive attitude toward the NBN, and the great benefits it will bring to rural communities. The NBN will deliver benefits to rural business, including dairy businesses. It is a 'build and they will come' type infrastructure, where uptake by farmers will be driven by showing benefit.

NBN will deliver benefits to regional dairy businesses.

It's an infrastructure project that I am really passionate about because it's in the area that I work in and the benefit that it will deliver to regional business I think is massive, and that includes dairy business. [INDUSTRY A]

The type of things dairy farmers will be able to do because of the NBN's ability to transfer large amounts of data at high speed are not yet fully identified.

So the ability for the dairy farmers to transfer large amounts of information backwards and forwards at very fast speed I think will be very liberating and something that we probably do not know what we can do with yet. So it's almost one of those things that 'build it and they will come' type scenario.
[INDUSTRY A]

Industry representatives have identified many ways the NBN can be beneficial in delivery of services, and in improving training opportunities.

...where all of a sudden those things that were difficult before and cost prohibitive, will become a lot easier to do... I mean we can run field days, potentially run field days where I go and mount a camera in the dairy and run a video stream of that out to farmers from every state in the country.
[INDUSTRY A]

Getting farmers to sign up to the NBN will be about the industry developing and demonstrating benefits that the farmer has not even contemplated yet.

...subsidy helps uptake but you still have to create and generate a reason for people to do it. So I think that's the first step. It's identifying the drivers of, well what am I going to do with this fast Internet? ... And a bit of this comes back to training I reckon. So the ability to roll out training solutions to remote regional communities, using shared desktop, using video conferencing, using the things that the NBN will bring us, that regional communities and farming communities do not even contemplate yet.
[INDUSTRY A]

5.6.4 Connection

The theme CONNECTION covers Internet connection. Internet access rurally is still a limiting factor to what can be offered to farmers. 3G has brought an improvement in speed over satellite, however 3G/4G plans are expensive for the data download that they offer. The location of robotic dairies is dependent on fast Internet. Farmers utilising robotics who have access to fast and reliable Internet have access to worldwide collaboration through software included with their robotic milking systems.

Next G has improved Internet access where it is available.

...[Internet] Has improved considerably over the last three or four years with the introduction of the Next G network. [INDUSTRY C]

Rural 3G and 4G plans are expensive and contain small data allowances making 3G and 4G Internet cost prohibitive.

...I see Telstra today released 4G and they're banging on about how good it's going to be. It probably is but you know, a 4G connection or an existing 3G connection in regional Australia is okay but is cost prohibitive. So a 12GB plan on the 3G network at the moment is \$90 a month. That's a lot of money and it's not a lot of data. Not these days... [INDUSTRY A]

Industry identified that the speed of the Internet currently available to the farmer is limiting the use of on-farm management systems such as for paddock management.

...whole farm management. So paddock management, effluent management, a lot of those things will be aided by faster bandwidth and the ability to image, to generate and display pictures... [INDUSTRY A]

Slow Internet speeds currently available to the farmer are limiting the type of support robotic milker manufacturers can give their clients.

[Key Performance Indicator assistance via international experts] ...We probably would like to offer more in that area and yes, faster and better more reliable Internet would help us to roll it out more. We work a lot also with web based seminars. To do that, you need reasonable speeds on the Internet... [INDUSTRY C]

A prerequisite for Robot installation is good quality fast and reliable Internet access. Satellite upload speeds in particular are not sufficient to provide the level of off-farm support robotic milking systems require.

[Satellite] It is good for farm [general farmer use], for download to the farm but our issue is to get information off the farm right and that's where the issue often is with the satellite. [INDUSTRY C]

5.6.5 Trust

The theme TRUST represents the fact that a lot of farmers are still writing things down on paper before transferring it into the computer, mainly because they are comfortable doing it this way, and it gives a backup in case of a computer crash.

[on using paper notebooks rather than palms – no smartphone apps available for this software yet]... yes, they are comfortable with that, they

have got a hard copy of it, if something crashes, it is getting it from the notebook into the computer... [INDUSTRY F]

5.6.6 Reliability

The theme RELIABILITY captures how reliability of systems (particularly automation or robot milking systems), is vital for customer satisfaction, and this feature is designed for by industry.

Cows must always be milked, and if a system breaks down meaning cows can't be milked, it is not accepted well by the farmer. Dairy shed ICT automation systems may be replaced with other systems from other companies by the farmer.

We had also sort of spoke to a lot of people who had other systems and were not happy...The biggest problem they had was breakdowns... a third of our sales were replacing other systems. [INDUSTRY D]

Agricultural ICT systems may be designed so the shed automation systems are able to be fixed by the farmer if required.

No it does not make any difference. Our systems can be all fixed by the farmers. That was part of our, when we set out to do this, it had to be able to be, well from a cost effective point of view. [INDUSTRY D]

Some agricultural ICT businesses have worked hard to develop a reliable and robust automated shed system in recognition that breakdowns are not an option to farmers.

Ours has got three fail safes. So if they've got an existing feed system, we generally leave that in place. So our system, if the computer dies, our system will take over from the computer and then we'll just start blanket feeding (feed the same amount to each cow) on pre-sets. Whatever the farmer sets. If that dies, our system will automatically shut down and put them back to their old system. If the power supply in our system dies, they can plug a motor bike battery into it and it will run. They can run a dairy on a motor bike battery for, oh they'll get through a milking quite easily... So we have really worked very hard... [INDUSTRY D]

5.6.7 Technology failing

The theme TECHNOLOGY FAILING captures that some ICT is released to the farm before it is fully tested, or 'bomb proof' in pasture based systems.

Activity meters are used to predict when a cow is 'on heat', rather than having to allocate human time, or have unskilled labour get it wrong. When a cow is 'on heat' she is ready to be inseminated. Activity meters are the most experimental of the mainstream automation systems.

...We came across a lot of people who said they just do not work, which was surprising. Most of those, I am guessing they probably do work but more than likely, they're not using it correctly. That's the most likely, because the stuff would have to work you would assume... [INDUSTRY D]

5.7 CHAPTER REFLECTIONS

This chapter has provided an analysis of the data collected in semi-structured interviews with six Industry representatives. The data collected from the Industry interviews provides an alternative lens in recognition that external factors that farmers may not be aware of are important to the current and future use of ICT on farm. This facilitates an inclusive whole, or integrated systems understanding of family farm businesses' use of ICT, and assists in the recognition of the situational context that surrounds farmers use of ICT. The data was analysed drawing on the principals of thematic coding guided by open coding. This chapter has presented five clusters of themes derived from the semi-structured interviews that constituted the data for the industry component of this research (Figure 5-1). The themes are presented and justified with extracts from the transcripts of the audio recordings from the semi-structured interviews.

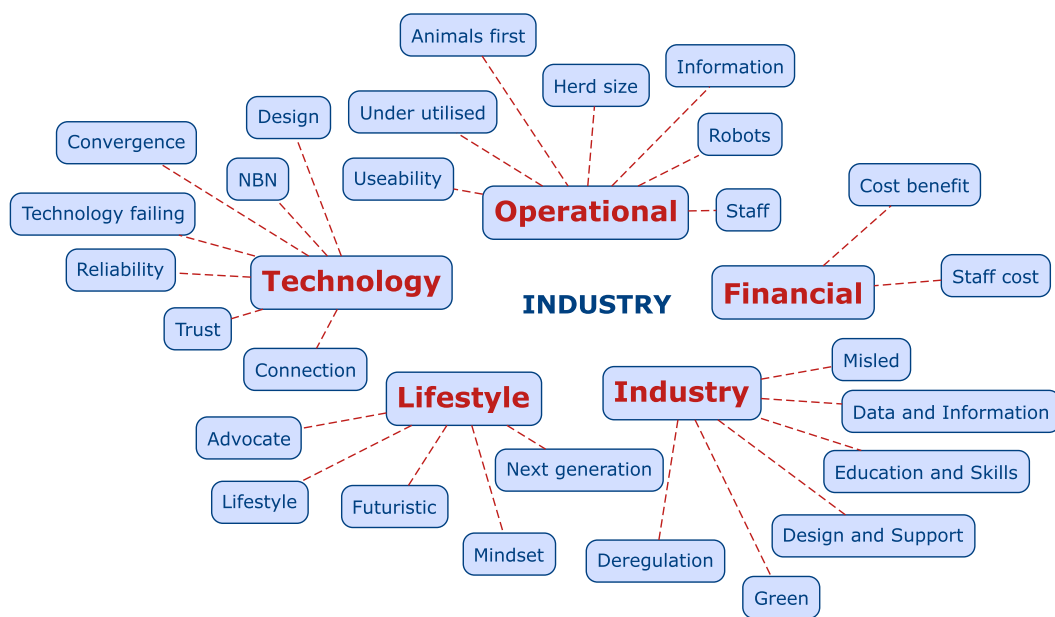


Figure 5-1 Summary of the 27 industry themes grouped into five clusters.

In the next chapter the rich description and the themes of Chapters 4 (Farmer interviews) and Chapter 5 (Industry interviews) summarised in Figure 5-2 are interpreted and discussed in relation to available literature.

CHAPTER 6

INTERPRETATION AND DISCUSSION

6.1 INTRODUCTION

This chapter distils the themes from Chapters 4 and 5 into eight overarching preliminary findings and discusses these in relation to the available literature. Demographics for farmer participant interviews are demonstrated by Table 3-1 and Table 3-2 in section 3.6.1.1. Comparatively, demographics for industry participants are demonstrated by Table 3-3, which can be found in section 3.6.2.1. The chapter is structured into the following sections:

- Section 6.2 provides an interpretation and discussion in relation to the available literature of the eight preliminary findings that emerged from the analysis of all the research stages (see Chapters 4 and 5). The terminology ‘farmer’ encompasses the family farm business and individuals as an entity;

Finding 1: ICT is used to interact with the wider business, rural, and personal community anytime, anywhere. ICT, whether in the form of computers, mobile phones or tablets is a great enabler of both social and business interactions for farmers, being increasingly central to how they live and work;

Finding 2: ICT is changing the way information is sourced. The use of computers and smartphones has changed the way farmers source technical information, and research and purchase equipment. This shift from local support to wider sources has changed the influence of the local rural support network;

Finding 3: ICT and herd management. ICT is used extensively in the milking shed, and on mobile devices to input data as well as to maintain social networks;

Finding 4: Infrastructure is essential. Continued investment in infrastructure is required to increase the utilisation of mobile smart technology. Farmers consider

access to NBN to be in the distant future and are not currently thinking about the implications, however industry can see significant future advantages;

Finding 5: Industry complexity and compatibility factors. There are significant compatibility issues in the dairy industry between individual farmer systems and also farmer systems and industry systems;

Finding 6: ICT and the next generation. In farms where the next generation is willing to come home, ICT may be used to attract them back to the farm. It is recognised by parents, that the next generation is not interested in working the long hours they did, seven days a week, 12 hours plus a day, or in doing the amount of manual work they have done;

Finding 7: Healthy work environment. ICT use on the farm is influenced how the farm runs as a whole with staff an integral component. This preliminary finding encompasses this blend of factors that creates a good working environment for the staff on the farm, and also the society and industry factors that contribute to this;

Finding 8: Lifestyle as a priority. Farmers' are making ICT decisions based on lifestyle priorities. All ages of farmers are making the decision to invest in ICT, with the older farmer utilising ICT to delay retirement.

- Section 6.3 provides a summary reflection of the chapter.

6.2 PRELIMINARY FINDINGS

6.2.1 *ICT used to interact with the community anytime, anywhere*

...because it's (iPhone) wireless, it picks up the system in the house so it's just a convenience thing and I've now got an Internet data package with it, that doesn't cost me any extra because of the phone usage, I can check emails and Internet – anything I want to do anywhere at any time. If I've got a spare minute while waiting for the cows to come to dairy, I'll scan the computer and see what's going on basically [FARMER 8]

ICT, whether in the form of computers, mobile phones or tablets is a great enabler of both social and business interactions for farmers, being increasingly central to how they live and work. The farmer's way of interacting with the 'outside world' has evolved, and has moved

towards less physical interactions such as driving into town to organise or research, and more to phone calls, text messages, e-mails, and on-line interactions. This communication has additionally become more mobile with phone calls increasingly being made via a mobile phone, and with the advent of smartphones; text messages, emails and on-line interactions can be made from anywhere. This is particularly significant when outside on the farm is the farmer's office. Historically, interaction with the outside world has had to be at defined times which normally coincides with meal breaks back at the house to make the best utilisation of time, or at night time because it is dark and nothing else can be done outside. This fundamental ability to communicate and access information while on the farm has changed the workplace for the farmer, providing instant easy access to information and services as they are needed instead of having to drive back to the house to make a phone call. This is as basic as having access to a phone to call the vet in the paddock if a cow is sick, or being able to take a photo of a weed in the paddock and e-mail it for instant identification to a specialist, or through using an app. The consequences of this are not just in making life easier, but time is money, one person can do more in a day, more efficiently.

Mobile phones have provided the opportunity for significant multi-tasking opportunities during routine and time consuming parts of the dairy-farming day. Bringing the cows in for milking happens twice a day, and normally involves sitting on a four-wheeler motorbike going at walking pace behind the cows to move them from the paddock (where the grass and feed is) to the milking shed. This time is a great opportunity to make phone calls or do some Internet research. This is a large part of the workday where historically nothing else can be done. The same principal can be applied during milking – milking may take five to six hours a day. Using a blue-tooth headset to keep the hands free for milking, phone calls can be made and received during this period. The ability to make these calls during the day has had major positive effects on family time at night.

Socially, the mobile phone has reduced the isolation of being a farmer. Short wave radios provided some communication, but a mobile phone is portable and can be used anywhere. It is very easy to text about the footy while following the cows on the four-wheeler, or mates can be rung at any time of the day to have a chat. Text messages are particularly useful, as they require less mobile phone reception than a phone call, with reception being a big problem on many dairy farms in Tasmania. E-mail is used to make requests for information outside working hours, or for quotes to be e-mailed.

For the 50% of farmers interviewed who have access to good mobile phone reception, the mobile phone also provides a way to manage and communicate with staff. Staff generally use their own phones due to mobile phones being easily lost and broken, and also the fact that staff often want to choose their own phone. However SIM cards may be provided to the employee, enabling the employer benefits such as free calls between staff mobiles due to all the mobile phones being on one phone account. In other words the mobile has replaced the short-wave radio for communication on the farm.

The convenience of using mobile technology and the user-friendly interface is more attractive than sitting at a desk in front of a computer. Emails are checked not only when out and about on the farm, but the phone will continue to be used when sitting at home rather than starting up the computer. Farmers who find it difficult to find time to enter cow information into the desktop computer, may find it easier to keep up with entering data via an 'app' on their smart phone. Some farmers only boot up the computer to clear their email off the server and to do the bookwork, with everything else being done on the smartphone.

Mobile phone use will be increased by addressing current usability issues such as durability phones are easy to drop and may get wet or lost and by improving the ability to swipe with gloves on to answer the phone. There is the occasional farmer who chooses not to take his mobile phone on the farm, instead 'valuing their time on the farm with the animals without distraction'. This was not found to be the norm however as most farmers liked the convenience of having a mobile with them.

The useability of smartphones is attractive. Attractions mentioned in interviews include the ease of access to contacts (compared to multiple menu options with a traditional Nokia interface), the weather data being visible directly on the screen, and it being easy to tap to find out more information.

The safety benefit of having a mobile phone while out on the farm is also recognised by many farmers. This may come from family pressure, or from the farmer wanting to be contactable due to other family members being unwell. The farm can be a dangerous work place due to the necessity to work with large machinery, the unpredictability of animals, the remoteness of the workplace, and the fact that many tasks are carried out in isolation. The mobile phone provides a degree of safety and reassurance to the individual and family members. One farmer told the story of his father (mostly retired) running out of petrol two

hours walk from a phone, and having to walk the two hours to make a phone call. The father had a mobile, but had forgotten to charge it! Another farmer got a mobile so his sick wife could reach him when needed at any time even if he was out on the farm.

Family farm businesses are run with an integrated family and farm agenda. While the role of the male is consistently hands on the farm, the role the female plays is diverse and flexible. On 16% of farms interviewed, the female was active in the day-to-day management of the farm, particularly management of the cows. The rest of the female farmers juggled off-farm work, kids, running a household and a more casual 'as needed' farm role. This consisted of activities such as milking, looking after the calves, doing the accounts, organising Internet connections and mobile phone plans, and liaising with farm business suppliers. The female was found to have started using a smartphone first, and to be a large instigator in the purchase and use of a phone and smartphone by their partner through providing one-on-one encouragement and guidance in the smartphones use. In general the female had better computer skills, and hence had a role in the use of the computer, the Internet, use of online social media, and online research.

The research shows that there are farms where the female in particular played an important role in encouraging and supporting the male in the use of the smartphone. They will purchase the appropriate smartphone, choose the appropriate mobile plan, and set up the phone with the favourite Elders weather site, for example, as the default weather source. Female also generally encourage the use of the Internet and have a better grasp of the associated costs.

The literature supports rural women being the key organiser on the farm, with particular strengths in ICT and sustainable development, with ICT use an integral component (Farmar-Bowers, 2009; Bellamy *et al.*, 2002). This research supports the role of women in regards to ICT in the family farm business.

This research supports industry reports (ABS, 2013; ACMA, 2013b) that rural communities are using mobile phones, showing increased use over the reported literature levels. This research supports the literature that mobile technology is useful for improving information access and provision for primary producers in rural areas (Lu and Swatman, 2008). Improved communications across all mediums, particularly mobile phones and email has resulted in better, faster and more timely information flow (Bryceson, 2003)

This research found farmers and all members of their family, irrespective of age, used mobile technology on a daily basis. This is in direct contrast to the literature (ACMA, 2012) which reported regional use of mobile technology was less than the metropolitan rate, and that age was negatively correlated with mobile use. This research found reception constraints was the main limitation on farmers' ability to fully utilise mobile phones, and smartphone technology.

6.2.2 ICT changing the way information is sourced

[Purchasing of a bale wrapper online from NSW] ... I would never have been able to find that without accessing the Internet. Before we used to do that sort of research we used to virtually limit ourselves to the machinery sales in Smithton and Burnie, just around the area. We used to never go outside the area to even look for anything. Well, how do you do it, magazines, or something like that - so we never worried about it before but once it was on the Internet it was sitting in front of me. You just tend to cycle through and see what you can find. [FARMER 3]

[Use of Internet] ...not having the knowledge locally, people couldn't give it to me locally, so you can tap away, and it is an amazing research tool. You put a word in there, and it does all this research for you just like that, and this gives you lots of options. Even at our poor download speed, it's bloody amazing, a bloody amazing tool isn't it, you know... For someone who is so remote, and openly, I have not really been anywhere, that, to be able to do that in such a remote location is just incredible. [Farmer 31]

The use of computers and smartphones has changed the way farmers' source technical information, and research and purchase equipment. Ninety per cent of farmers interviewed researched online, and 70% stated that they had purchased online. This shift from local support to wider sources has changed the influence of the local rural support network. Historically farmers have relied on their local representatives for information and recommendations, often using the same businesses their parents did, with the representatives often coming out to visit the farm. This strong community connection was still very evident in a number of interviews, however also evident were the farmers who used the Internet to source information, services, and product from further afield. Some farmers utilised a combination of local and Internet resources, by researching online, and then approaching their local services agents to source the product.

The sourcing of information using ICT has continued through to the extension industry. The extension industry is a well-established sector consisting of government funded as well as independent consultants. Traditional extension consists primarily of farmer field days on a

farm, the farmer being part of an extension group that meets on members' farms or by physical participation in courses. The limitations with these modes of delivery include inflexibility in delivery time and content, the travel time to the delivery site, the wide range of farmer interests needing to be catered for, and the ability to access 'specialists' in a small rural community. Utilising ICT, farmers are utilising online research and direct communication methods such as e-mails with specialists. This is a much more efficient use of time than driving to an extension group up to two hours away, only to find the content was not useful. This search for information does not have to be restricted to Australian sources – New Zealand websites are often used, and e-mail support for New Zealand designed technology sourced.

Where the sourcing of information utilising ICT outside the local area for traditional topics is bypassing local knowledge, in the case of highly technical fields, such as robotic milkers, or fully automated milking sheds, this is the only way this technology has been able to be installed in rural locations. There is not the client base rurally to support specialists in these technical areas. Farmers using robotic milkers utilise knowledge internationally regularly, with the ability to send an email one night, and to have the reply e-mail when they get up the next morning. Robotic farmers still required the provision of region specific technical advice in topics such as the grazing management of herds farmed using robotics. Robotic milking systems in a grazing environment is a relatively new application of this technology, and an area of industry research and funding. The two suppliers of robotics in Australia both have extensive experience in application of this technology in the traditional international barn system, but less experience in the grazing environment Australia utilises this technology with.

The technical service industry considered there were significant benefits associated with their ability to interact directly with farmers utilising ICT, with those interviewed considering the quality of local ICT services available to farmers to be quite poor. Industry interviewed expressed criticism over local advice offered to farmers, considering local ICT providers to be selling what is financially most beneficial for the business rather than what is best for the client. When poor ICT advice was provided by local business, industry participants interviewed stepped in so they could get their product working on farm, but also out of a wish to support the farmer.

The importance of online activities such as social media have been recognised as being essential to regional innovation (Higgins, 2011), however the resulting changing

relationship within the local community is not considered. This research supports the literature that adoption of ICT in agricultural systems is closely linked to social, political and economic drivers (Sassenrath *et al.*, 2008; Apps and Idding, 1990; Taragola and Van Lierde, 2010; Csoto, 2011; Alvarez and Nuthall, 2006).

6.2.3 ICT and herd management

...the support network and the training - that is what it is all about at the end of the day, if the farmer doesn't get it, he won't use the system. He has got to get in and want to use it, and we can show him how to use it, and then they take it and run. But if they don't get that initial training... They just need ongoing training, they really do". [Industry]

Forty per cent of farmers interviewed had ICT installed in the milking shed. Shed ICT utilising individual cow identification to enable individual cow management and animal health and production recording, or alternatively robotics, is often the last thing to be put in, as dairy farmers generally have to get the farm physically right first (fencing, grasses, general infrastructure) before it is felt that money can be invested in ICT. Cows can be milked without ICT if required – fences and water are essential however. Fifty per cent of farmers cited cost as the reason for not having ICT, or more ICT in the milking shed, with 16% having no interest in utilising ICT in the milking shed. The reasons for this were either retirement, uncertainty about whether farm was going to be passed on to future generations, or the view that ICT does not have a place in the shed, or a combination of the above.

Investment in shed technology can take two paths. If the shed is seen to be able to be used, ongoing upgrades may be invested in. If it is considered that the current shed is not suitable for upgrade, the current shed is not invested in and a significant level of ICT is invested in for the new shed. Industry has noticed a change in philosophy in recent years with more farmers opting for 'all the bells and whistles' to be installed right from the initial shed build, rather than have technology installed as it is needed. This perplexes some in the industry as despite all the support they can offer to encourage the farmer to use this fully automated system they have paid extra money for, it sometimes goes unused, which leaves industry wondering why they paid the extra for it. This research found industry reported more ICT being installed than used. Literature (Errington and Gasson, 1993)

suggests this may be because a family member is planned as a successor with this changing investment priorities due to forward planning by the current family farm operators.

ICT in the milking routine

As the cow comes into the shed, she may or may not need to be identified as an individual depending whether the farmer is feeding each individual cow a unique feed mix, or whether a specific cow needs to be drafted out for any particular reason (such as to be mated, sold, or dried off for example), or if a specific cow needs treating individually during milking. If drafting is required, identification options include visual ear tags in the ears, but these require reading from a different position to where the cups are put on, freeze branding³ which is the best visual method, from the 'pit' in the milking shed or alternatively utilising electronic ID, where the number of the cow is shown on the milking machine display. This electronic method must be used if individual cow feeding (where each cow gets a different amount of grain as per the farmers pre-set criteria) is installed, as then the automatic feeder dispenses the correct amount in front of each cow without the operator having to do anything. Individual cow feeding is essential in a high grain feeding system, as cows must be slowly built up to high levels of grain, and with cows calving at different times, they cannot just go into the herd and get what the herd is getting as this will kill them. An individualised feeding system allows a freshly calved cow to be in the main herd, yet get a different level of grain. This individualised feeding system is one of the main reasons farmers first choose to install an electronic identification (ID) system in the milking shed.

It is important for the person putting the cups on the cow at milking to recognise not only individual cows, but know which cows should not be milked, with both of these components becoming harder as the herd gets bigger. This is where electronic ID is very useful, as it means that anyone can put the cups on the cow as the herd management system the electronic ID is connected to is 'fool proof' in that it will not let the cups be put on cows that should not have their milk go into the vat. Examples of this include cows that have been treated with antibiotics for mastitis – if milk from one cow with antibiotics goes

³ Freeze branding uses a branding iron that has been chilled with a coolant such as liquid nitrogen. A freeze brand damages the pigment-producing hair cells, causing the animal's hair to grow white where the brand has been applied. It is more effective in dark coloured animals, although still used in light coated animals.

in the vat the whole vat of milk, which may contain the milk from up to four milkings, has to be dumped with the farmer not being paid anything.

This electronic ID in the shed is done using RFID, with a reader being placed as the cow enters the shed. This electronic cow identification system, besides being linked into feeding, and the actual milking process, can also be used to automatically separate (draft out) a cow from her herd mates as she leaves the milking shed if required. This saves a human having to stop what they are doing to do this, or an extra labour unit being employed specifically for this role. It also saves human error through missing the cow, and assists occupational health and safety through reducing the amount of physical stock handling (and having to run down the race after the cow that got missed in gumboots...). Correct drafting out of cows is essential at mating time, as the cows must get inseminated the day that she is 'on heat'.

Individual identification of cows in the milking shed can be linked to a milk metering system which provides the farmer with individual per cow milk production on a per milking basis, and also the ability to be linked into conductivity testing for mastitis. The ability to detect mastitis becomes more difficult in large herds as it is harder to know individual cows due to the physical number of them, but also there is likely to be many more people milking them, meaning familiarity with individual cows and what is 'normal' for them is reduced. Detecting mastitis is important for farmers due to financial penalties for milk with high Somatic Cell Counts (SCC). Mastitis is additionally an animal welfare concern.

Herd reproductive management or more specifically when an individual cow is 'on heat' or ready to be mated or inseminated can be predicted using ICT. Pedometers or activity meters are attached to each individual cow, this information is sent to a central computer, and software is able to predict when she is on heat based on her changed activity levels. There are some technology feasibility and cost issues currently on large dairy farms in implementing this system. This includes problems with how the activity data is collected into a central processing point, with it currently being very expensive to put antenna out on the farm to collect the information. Additionally activity meters are currently expensive. The activity data needs to be processed before the cows gets to the milking shed so she can be drafted or separated out using automation when needed for mating.

All the information collected from the cow electronically, or manually by the farmer if required, is collated in herd management software, which may or may not be utilised

during milking. This information can then be accessed and interpreted by the farmer. Robotic milking systems, or fully automated dairies collect significant quantities of data during milking. These systems incorporate sophisticated reporting systems where 'action items' are automatically created; with the aim of ensuring the farmer is not overwhelmed by the amount of information being collected. It is this interactive and interpretive component of herd management software that industry believe farm staff should be encouraged and allowed to be more involved in. The industry vision for this technology enables the farmer to walk into the paddock with their mobile phone, and access which cows are on heat, which cows have mastitis, are lame, historical milk production, or any other piece of information that facilitates easy management. This cloud ability, when infrastructure provides Internet access over the total area of a farm, will negate current system operating problems such as requiring antenna for pedometer information to be transmitted to the milking shed for processing.

The input of information into herd management systems can be problematic, and has been identified by farmers as time consuming and a chore unless there is a clear direct farmer benefit. Industry identifies the best farmer data entry compliance to be when small amounts of data are entered directly at the time of the event, such as in a milking shed that is automated – the computer needs a calving date for the cow to be milked. Hand held devices for entering calving data in the paddock at the time of the calving are currently not considered a realistic option. This is due to farmers believing their staff are not capable of operating the ICT reliably, particularly those with large herds and workforce (a trust and training issue), and also due to concerns over durability of the technology with mud, dirty and rain that generally goes with calving over winter and spring in a pastoral calving environment. The device used for input also influences utilisation rates when trying to get information entered into herd management systems. Industry has found that hand held devices (whether Palms, smartphones or tablets) are more likely to be used than a traditional desktop computer. Farmers would prefer to sit down in the lounge or at the kitchen table and enter data on a mobile device than sit down in front of a computer. The ease of data entry into a herd management system can be the difference between a farm using this technology or not. Interviewed farmers included those who had stopped using systems because they got too far behind in data entry, or it was considered too time consuming for benefit gained. To address this, Industry commented that it had done pilots with using mobile computing devices with farmers who struggled to turn on a computer and enter the cow information. The feedback was very positive with farmers finding the

entering process much easier, and it can also be done while sitting at the kitchen table or in the lounge in front of TV.

This research confirms that farmer use of ICT may be less than industry reports suggest (Liao and Martin, 2009), with farmers not utilising all the ICT purchased in a shed. Literature and industry reports identify a key driver in improving farm performance to be the provision and adoption of more efficient technologies and management practices (DAFF, 2005), yet farmers investment choices place shed ICT to be of low priority. This suggests farmers do not place a monetary value on the value of ICT, but rather identify with physical aspects of shed improvement. There is an industry goal by 2025 of increased participation by Australian food business in the digital economy to drive productivity gains, innovation and to create connections with global markets (DAFF, 2013).

Automatic calf feeders are a piece of ICT on the farm that were at times a surprise to find, with 20% of the farms interviewed utilising robotic calf feeders. These machines feed individual calves automatically throughout the day whenever a calf enters the feeding area. They greatly reduce the physical labour required in feeding calves, which consists of manhandling 40kg animals to get them to drink, and carting and lifting buckets of milk to pour into calf feeders. The realistic outcome with installation of calf feeders is it takes the same amount of time to feed and look after the calves, but it can be done anytime during the day. Additionally, the calves are better grown, weighing more. Robotic calf feeders are readily acceptable to all generations, with this research finding installations were often initiated by parents who had retired from milking, but taken over the calves. The contentment of the calves being able to eat as much as they want whenever they want (industry refers to this as 'adlib feeding') instead of manually once a day resulted in reduced bellowing. This animal contentment was a key driver in the choice to use robotic calf feeders. The younger generation was there to do the technical calf setting up on the computer if required. This 'older generation' does not mind ICT if there is a purpose' theme continued when a farm was interviewed where the younger generation had pulled out the robotic calf feeders the father had installed. The reasons for this were many and interesting. Reasons given included difficult to use, cleaning problems, milk going off, calf management problems, sick calves and staffing issues at weekends. All but staffing issues suggests lack of manufacturer support as far as training, but also in follow-up support to recognise the farmer is having problems, and assisting to find solutions. Upgrades in software could easily have addressed the specific 'took too long to enter a calf into the

system before it could be fed'; calf management problems could have been worked through and solutions found with the support dealer, with some of these being 'practical' such as 'get a second hand vat and chill the calf milk in that so it does not go off'. The staffing issues reflect back to the reflection that whether it is a robotic calf feeder, a robotic milker, or a fully automated rotary dairy, ICT does not replace good quality human labour, and the machinery does not look after itself. The majority of farmers interviewed said one person looked after the calves for consistency, in this particular farm, over the weekend casual staff got criticised for not looking after the calves correctly. This highlights the need for staff training, but also the potentially unrealistic expectations of the farmer, expecting weekend staff, who may not normally deal with calves, to look after them.

Not all robotic feeding systems use the NLIS tags, with the Lely system using Lely's own collar. This has stopped one farmer from implementing robotic calf feeders due to the cost of the collars. Because their milking system was Lely it was never considered that another system could be used that utilised the NLIS tag that all calves have to have in their ears due to industry regulation. This is an example of not only a farmer having blinkers on to one manufacturer and not being able to think laterally to other options, but also an example of an international company not adapting its system so it works cheaply and effectively in the Australian environment. It also highlights the benefit the industry could gain through readily accessible external ICT consultants.

ICT support in the industry

The manufacturer of agricultural ICT extensively supports farmers. Help is always just a phone call away, and training is provided with the installation of systems. However whether the farmer chooses to use this support is variable. If a farmer gets behind in entering cow data, the industry can assist the farmer to catch up. However the industry is often not aware of the problem (i.e. the farmer does not ring for help), until it is too late and the farmer has either given up, or alternatively spent unnecessary days catching up. ICT manufacturers commented that they like to hear from farmers as it means they are trying to use the system, and eventually they 'get it' and stop needing phone calls. A phone call was found to be the preferred method to contact support (easiest), with one industry business interviewed recently stopping the forum support for their ICT product due to no-one using it, with customers preferring to ring. Providing phone support in the dairy can be difficult due to there often not being any mobile phone reception at the shed, with half of the farmers interviewed reporting reception problems on farm. This may therefore require relaying of instructions between two people, or the racing between milking shed computer

and phone wherever reception is available. Robot farmers enjoy the extra level of support provided by international technicians who are accessed through e-mail. These farmers are able to e-mail these representatives for example in the evening, and get a response back the next morning due to the difference in time zones.

Literature has identified a slow adoption of precision agriculture due to a lack of functioning decision making tools (McBratney *et al.*, 2005), and interface difficulties (such as time consuming to use) (Car *et al.*, 2012) and recommends redesigning focusing on agricultural user needs (Maruster *et al.*, 2009), with the current ability to collect data exceeding our ability to understand and apply the data in a meaningful way (Lamb *et al.*, 2008). Systems should be fully integrated to ensure a coordinated execution of activities (Pietersma *et al.*, 1998). This research supports the literature that interface difficulties contribute to the slow adoption of ICT and found a wide range in the usability of individual systems. This research found farmers were not utilising the full ability of herd management systems to analyse and interpret the large quantities of data being collected on farm.

ICT and labour relationships

[Staff interaction with shed ICT] *Definitely, any staff member that shows interest, then definitely. There are some who are quite blatant in that they are not interested, I just want to come and milk and go home, and then I have got others who ask how do you use the computer, and how do you do this and that...* [FARMER 30]

ICT is installed in a milking shed for a variety of reasons. The benefit for the milker is that there is less to remember and hence milking is easier, due to the fact ICT is capable of largely automating components of the milking such as drafting, heat detection, and identification of cows that should not be milked. The advantage for the owner is that the risk and worry about 'human error' can be reduced, because ICT is acting as a 'backup check' or 'failsafe'. The quality of staff and milkers that the farmer employs, and hence the number of mistakes likely to happen, impacts on the priority that needs to be placed on risk management through investments such as ICT in the dairy shed.

The use of ICT does not necessarily have to mean milking is not interesting, just as long as staff are encouraged to participate in the herd management, and as such have access and the opportunity to interpret and utilise the information that is collected during milkings. Use of ICT allows staff to for example see how much milk a cow has produced in real time, which adds another dimension to the milking routine, but additionally the ability to use the

information gathered to interpret and manage the herd. However, the majority of staff did not have this level of involvement in the data collected, and the interpretation of the data collected.

Perceived relief from the daily milking routine can be a large motivator to put in an AMS. However the AMS also has the potential to be more than a substitute for labour, with automatic sensors providing detailed information about each cow, which was not easily obtained with previous management and milking systems (Spahr and Maltz, 1997). Tipples *et al.* (2004), identified the future of staffing in the dairy industry would be a transition to a smaller but more technically competent and qualified workforce. This research found the dairy sector has yet to move to a more technically competent and qualified workforce.

However this research found 10% of farmers interviewed did not 'trust' ICT in the shed to provide them with enough or the right information to enable management of their cows. It was felt that they needed to physically see the cows at milking time to know how they were. This sentiment came from owners of small to medium sized herds that milked the cows themselves on a regular basis. As soon as the herd gets larger and staff are employed, the owner is forced to rely on others and/or technology to look after the cows.

The view that one has to be physically milking the cows to have a relationship with them, or know their health status is disagreed with by both of the farmers interviewed who utilise robotic milkers. These farmers consider that the 20 seconds you spend looking at a cow while putting the cups on in a traditional system is not enough time to be of real benefit. The farmers utilising robotic milkers interviewed considered that they actually had a much better cow relationship now than before the robots. To understand this philosophy one needs to understand the milking process. Milking is a stressful time for cows and farmers - twice a day the cows walk to the milking shed, and stand on a concrete yard waiting for their ten minutes in the shed to be milked. Cows are either milked in batches of up to 40 in a herringbone, or walk onto a revolving platform in a Rotary shed one at a time. From arriving at the shed to getting off the platform the last cow may have been standing on concrete for two hours. Due to the fact it can take 2½ hours to milk, particularly at night time staff are in a hurry to finish and go home. This means that staff are impatient for the cows to move quickly into the shed, get milked, and get out. Farmers utilising robotics were surprised by the change in cow behaviour when they installed robots, commenting that now they are happy for their kids to be around the cows as they are content and 'different animals'. It was also pointed out that the farmer could go and stand in the

paddock and view the cows any time, so the argument of losing contact with the cows does not prove to be the case in reality. It is also possible to stand next to the robots and view the cows as they are milked, with instant access to information coming from the milking machines in regards to milk quality and animal health and reproduction data.

Herd size is where philosophies around ICT become very apparent. Herd size has been increasing over the years, and whether maintaining knowledge about individual cows is a priority with this herd size increase is a very easy way to distinguish philosophies. With small to medium sized herds (less than say 250-300 cows), there is an option to be familiar with every cow individually without having to use ICT, additionally the owner is often more involved with milking as this number of cows requires less labour to be employed. However once herd sizes increase there has to be a decision whether knowing what each individual cow is doing is a priority for the farm. Farmers approach this in different ways. Some farmers consider they want average milk producing cows that don't need extra attention, so have no ICT in the shed. Other farmers see benefits in knowing what each individual cow is producing so they can feed grain in the shed relative to how much milk the cow is producing. The other benefit of ICT in the shed is safety for the cows when grain is being fed. The cow cannot just be suddenly fed eight kg of grain, but rather this must be introduced slowly over a couple of weeks. This is where ICT in large sheds is essential to ensure the right amount of grain is fed on a per cow basis. The cows are recognised individually as they enter the shed, and the right amount of grain is fed based on their milk production and stage of lactation. The mature farmer accepts that technology is the way farming is heading due to the increased herd size, and hence the need for technology (ICT) to maintain individual cow care. The choice to take on this change depends on the future vision for the farm and whether there is a next generation coming back to the farm.

The literature identified trust to be an impediment to the development of electronic relationships in the agri-food chain (Canavari *et al.*, 2010). Vanclay (2004), considers an understanding of social issues, the social nature of farming, and the social basis of adoption social principals to be fundamental to trusting ICT. This social basis of adoption has been identified by industry through reports a better understanding of human factors in the adoption of research in the agriculture and food industries are important to ensure intended research and development outcomes are achieved (DAFF, 2007). This research supports the literature that trust in technology is a factor in adoption on some farms. The need to understand human factors in the adoption of ICT is also supported by this research.

6.2.4 Infrastructure essential

I get reception by that window so when the kids come home they put their phones by that windowsill, that's the only place in the house that you get it. I didn't use to take the phone with me much (on the farm) but I tend to take it a bit now and I probably use it a bit more. There are patches [of reception], you can find patches of it. You probably can SMS, you only need one bar for that but as far as making phone calls it's pretty hopeless. It's frustrating because every time we bring it up they [supplier of phone service] say you get full coverage there, well that's what your map says [we say], but we tell them that we don't get full coverage. [FARMER 15]

All but one farmer interviewed had a computer and access to the Internet. Farmers generally accept that the speed of the Internet is slower on the farm than at their friend's place in town, however 40% of farmers interviewed still considered Internet speed or access to be an ongoing problem. Based on speed and reliability wireless or ADSL is preferred over satellite, however wireless is expensive with restrictive data plans which limit the realistic capability of using technology such as Skype. The high saturation of satellite Internet on interviewed farms (45%) was due to the 'Australian Broadband Guarantee' which ended on the 30 June 2011, which assisted the majority of farmers who did not have ADSL-equivalent Internet speed to obtain a subsidy on satellite access. The farmers who are computer savvy make satellite their last option due to slow speeds, however the majority of farmers are still on satellite as there is often no other option. It is interesting to note that there are a proportion of dairy farmers who consciously live close to town for infrastructure such as Internet and access to shops and children's schooling. This will be reflected on further in section 6.2.8.

Currently the industry can see more opportunities for fast Internet than the farmer, with industry seeing many opportunities for farm enterprises. Industry is of the opinion 'build it and they will come'. Industry may be correct in this regard, with some farmers indicating the main reason they got the Internet was industry and supplier expectation (so being 'dragged along' by industry). Farmers themselves were very sceptical and disinterested about the NBN in Tasmania, believing the NBN is years away from reaching them, if it gets there at all. Thirty-nine per cent of farmers interviewed said they would be interested in the NBN if it became available to them, with another 26% directly saying they were not following the NBN because they did not believe it would reach them. The NBN is a topic that farmers currently are not paying significant interest, preferring to wait until the service

is offered to them before deciding whether to adopt. Meanwhile, 48% of farmers are on comparatively expensive and slow satellite services and another 35% on wireless, which is faster but expensive per gigabyte.

Internet access on the farm is important not only for the farmer looking out, but also for the support services looking in. From a farmer perspective this allows interaction with the farm while they are not there. This in particular affects their personal and family life, as holidays can be taken while keeping an eye on the farm, in the form of monitoring how the cows are milking, or starting the irrigator from the holiday house, or even from overseas. This type of Internet access also means industry is able to support farmers in a much more timely fashion and far more effectively, as computers can be accessed remotely, diagnostics run, cow management monitored, or training on how to use the technology provided remotely.

In discussion with farmers, mobile reception was often brought up as a significant problem on the majority of farms with 55% of farmers specifically stating they had mobile phone reception problems while out on the farm and in their house. Often mobiles would only work in certain parts of the house, with it not being uncommon to see a line-up of mobiles on a specific windowsill, where text messages could be received. However mobile phone calls may not be able to be made from inside the house – taking the phone off the windowsill to make the call can mean a loss of reception, which is a frustration for the whole family. Coping mechanisms for intermittent reception include the use of text messages, and the taking of photos (such as pasture), or anything else of interest, which are sent (e-mailed) when in reception range. The issue of reception also influences the type of mobile phone used. Some farmers believe the old Nokia phones to have better reception and to be more durable, choosing to use these instead of smartphones. All farmers interviewed used Telstra as their provider due to reception (see Table 3-2). If mobile reception were reliable, some farmers would have considered replacing their landline with mobiles. This is particularly attractive for farmers due to the quality of copper lines in rural locations, with heavy rain regularly causing loss of the landline, or electric fences creating clicking on the line from a short circuit. The other reason for only using a mobile is cost; some farmers look at the cost of a landline and consider it better to increase their mobile plans.

Internet access on smartphones, both in willingness to use and availability was very varied. Some farmers had good Internet access on their phones, and used this as their main source

of the Internet by preference, with the traditional desktop computer only being used for e-mail. In other cases the farmer was aware they could access the Internet by using their phone, but were unsure of the costs associated with it. In this case, it was the wives that had prompted the smartphone purchase, set up the plans, and were trying to educate their husbands. It is access to wireless Internet that industry considers has the greatest opportunity for change on the farm. The ability to walk into a paddock of cows and instantly know which cows are on heat and identify any cows that have health issues is significant and currently often missing due to limited phone and Internet connection on-farm.

Literature reports 99% of the Australian population has 3G coverage (ACMA, 2010), however for mobile technology to be useful from a farm management and reference perspective, reception needs to be consistently available. Reviewing coverage maps (Telstra, 2014) provides a better representation of the true access available to the rural community, and supports this research's findings that mobile phone coverage is consistently limiting for farmers. This research supported the literature findings of increased mobile utilisation in the community despite limited reception (ABS, 2013; ACMA, 2013b). The rural community has not come to totally rely on the mobile phone to replace the land line, with this lag being supported by the literature (ACMA, 2013c). The reasons for this lag that were found in this research, such as reduced access to upgraded networks, is also supported by the literature.

The literature supports the high level of ICT use found by the study (ACMA, 2012), emphasising that Internet access is vital for interaction with social media for innovation (Higgins, 2011). Hunt *et al.* (2012) are more specific and specify rapid expansion of broadband capabilities into rural and regional Australia for national coverage is important for information exchange in agriculture.

6.2.5 Industry complexity and compatibility factors

Their [international supplier of herd management software] argument is their data is in an ISO format so an international standard, not just Australian, it's international, except it's not used in Australia which is difficult. Yeah, so that makes life difficult getting data back and forth simply. [INDUSTRY]

This system [robotic calf feeder] doesn't recognise the NLIS tags [compulsory electronic ID for all Australian cattle], so it is a bit of a

nuisance, you could put them in the little calves, and bang you have got their life number if you like. The system doesn't recognise that, and at nearly \$300 a collar, by the time you put the gear on it, you can't put a collar on a calf, because we haven't got that much money, so you can't put a collar on them until they calve as heifers, or until you are breaking them in, so your identification is still with tags in the calves. [FARMER 31]

There are significant compatibility issues in the dairy industry between ICT systems. Fifty per cent of farms with ICT installed in the shed reported experiencing compatibility problems either during installation, in the first few months, or had compatibility problems that had not been solved, resulting in components of ICT systems not currently being used. Compatibility problems arise trying to transfer data between systems, and also with installation of components from different manufactures. While there are minimal compatibility problems between Australian designed systems, ICT can be brought in from any part of the world and sold to the Australian dairy farmer, and farmers can additionally buy and import anything they want. System compatibility questions generally are not even thought about until the system is in and it is found the existing technology does not talk to the new. This is as much a manufactures or sales person's responsibility as the farmer's. Farmers are not ICT savvy enough (or just busy with day-to-day farm management), and are generally fairly trusting of the rural sales person, and just do not think to ask 'can I get information from this system to this one', or 'will my existing drafting gate work with the new one'. That is until the system is in, and they find they cannot do something like herd test that has always been taken for granted. It is also hard for dairy farmers to find knowledgeable independent advice on not only the integration of systems, but objective advice on what system is best for them.

The importance to the industry of having access to the dairy farmers' herd information is demonstrated when discussing the requirements for Australia to calculate the genetic merit of bulls. The Australian dairy industry creates 'breeding values' to estimate the genetic gain to the farmer for bulls that are used and sold in the industry for artificial insemination. These 'breeding values' are created by using information that is derived from farmer information on factors such as the production, health, temperament, and likeability of the cows. These are used to estimate genetic breeding values such as milk production, fertility levels, susceptibility to mastitis, and longevity. This information is now often kept on farm in isolation from the industry in internationally designed dairy herd management systems because of limited ability to transfer the information. The Australian dairy industry is

currently grappling with how to access the wealth of cow information that is presently only on farm. This problem is not something that the average dairy farmer is concerned about because the dairy industry has not put any value on the information. While this has a long-term impact on the dairy farmer through the industry having less opportunity to provide relevant support and research into issues developing on farm, it is not something that can easily have a value put on it.

In addition to commercial companies selling internationally designed systems, more adventuresome farmers will buy ICT independently and import themselves from overseas. The sourcing of this international piece of ICT creates compatibility problems, with farmers rarely considering integration capabilities of the purchase. Australian based designers and manufacturers of herd management and dairy shed systems are significantly more responsive to individual farmer requirements, and will adapt ICT as required. Often however, the farmer is not aware that these designers and manufacturers will do this.

Computerised information systems can potentially help the dairy producer to deal with the increased complexity of decision-making and the availability of information in dairy farming. These systems however should be fully integrated to ensure a coordinated execution of dairy farming activities (Pietersma *et al.*, 1998). Complexity of systems has been previously identified as a barrier to adoption (Cox, 1996; Alvarez and Nuthall, 2006). The need for support of the farmer to use new computerised systems was identified by Alvarez and Nuthall (2006).

6.2.6 ICT and the next generation

Geoff often thinks that his father isn't progressive which is a generational thing and it comes back I always say to him... 'Yeah, the older generation have got everything to lose and nothing to gain and the younger generation have got everything to gain and nothing to lose because they haven't got the capital stake in the short time period. [FARMER 17]

Where the plan is for future generations to stay on the land and continue the family farm there is no question about continued ICT investment on the farm, rather how and when this will occur. It may be expected that one of the kids take over the farm, with this expectation coming as much from the other siblings as the parents. An alternative to this is the farm is set up so it is held in the family, but a manager is put on. In this case significant ICT can be

installed so the family members not on the farm can monitor the farm. In farms where the next generation is willing to come home, ICT may be used to attract them back to the farm. It is recognised by parents that the next generation is not interested in working the long hours they did (seven days a week, 12 hours plus a day), or in doing the amount of manual work they have done. ICT is used to make milking easier, and to collect data about the cows that can be used to monitor the farm in a way the next generation is attracted to, and the older generation never considered. Robots in this instance appeal to the younger generation as it means dairy farming fits more into the nine-to-five 'office hours' type work schedule.

Forty-five per cent of farms interviewed had two generations involved in running the farm. The changeover between generations is a difficult time and may go on for years with the older generation wanting to stay involved, potentially causing conflict between the younger generation who wants to invest and change things, and the older generation whose retirement money is being spent. Where it is not known if the next generation will take over the family farm or not, the farmer's approach varies depending on their individual situation and preferences. The farmer may just continue to hold on and 'tread water' with no significant investments until it is known if a family member will come back onto the farm. Another option is if they are still interested in the cows, but less in the physical side, ICT in the milking shed may be invested in so they can stay on the farm for longer. In this situation farm staff may be employed but the farmer continues to manage the farm and the cows because they know what is going on due to the information on milk production, udder health and fertility coming from the ICT installed in the shed. Robots are another option in this case as it reduces the physical nature of farming because the cows have to be physically handled less, and creates lifestyle opportunities without the staff management problems. Other farmers consider the farm not to be where they want their kids to be, and the kids are actively discouraged from returning to the farm. In this case investment choices are simplified, with the investment decisions being focused on the current generation's priorities only.

The literature supports the research findings that family and generational factors are significant in the farm management and investment decisions made (Errington and Gasson, 1993; Waters *et al.*, 2009), and the effects of family farm development on the farm organisational structure reported by Symes (1972) whereby variations in farm performance may be explained by the stage of the family cycle.

6.2.7 Healthy work environment'

We need to change the schooling around so that it becomes a career, not the last thing you do because you can't get another job. [FARMER 11]

ICT use on the farm is influenced by how the farm runs as a whole with staff an integral component. This preliminary finding encompasses this blend of factors that creates a good working environment for the staff on the farm including the use of ICT to improve the work conditions and staff involvement in ICT decisions. Society and industry factors that contribute to this are also important, including community perspectives on the dairy industry being a place for the next generation. This has an impact on the type and quality of young labour entering the dairy sector.

The dairy industry has a reputation for long working hours and poor pay. The long working hours come about through having to milk the cows twice a day. This often means a four am start and not finishing until six pm at night, and longer during calving, with these working hours make the industry unattractive to work in. For those who are educated, why would you choose to work twelve-hour days when a nine am to five pm job is possible? Farmers' are starting to realise that they need to pay significantly better money to attract good quality staff to counteract less than attractive work hours. It was felt by farmers that the industry needs to support the farmer better through a better milk price to allow this required increase in pay to be realistic. This is where the prospect of robots comes in because the work hours can be closer to 'office hours', and it is hoped by farmers that this will attract better quality staff (for example a university graduate who is more management and computer orientated).

Not all farmers are recognising and addressing that work conditions on the farm need to be improved. This was demonstrated in a male farmer interview with the comment 'I don't have to do the job, so there is no problem'. This particular comment was in the discussion on how long milking takes, and it was the female in the interview who then went on to say that workplace safety was an issue with this and that they did need to make sure staff did not have to do this more than once a day, due to the repetitiveness of the work, and the long hours standing on hard surfaces. This situation was not considered ideal, with milking taking over three hours, with no ICT in the shed. ICT has a role in improving the working conditions on the farm, but that improvements should be made needs to be recognised first.

The dairy industry has problems retaining good quality staff. The reasons for this are more than the long hours. Some farmers had no problems retaining staff, whereas others had continuous problems, with the difference being how staff were treated and valued. Those who had no problems retaining staff supported attendance at field days, workshops, and training courses and encouraged staff to bring back ideas that would be discussed and implemented if appropriate. Industry considered the majority of farmers to be poor staff managers, considering the quality of employees in the industry to be a result of the farm work environment. It was specifically suggested that staff should be involved in ICT decisions and implementation to provide a sense of ownership in the job, with industry representatives believing this to be a successful strategy in their own businesses. The current aptitude and disinterest of staff in ICT on the farm may make it difficult in the short-term for farmers to involve their staff in the herd management interpretation and use of information gathered electronically. However staff must be encouraged, trusted, and given the opportunity to show an interest. This research found a diverse cross-section of farmer attitudes, with the farmers who involved their staff in herd management and purchasing decisions seeing the benefits through a stable workforce, and conscientious employees.

The literature supports finding of a high turnover of staff (Dairy Australia, 2012a). The dairy industry has significant issues attracting a farm workforce due to its reputation for a lack of promotional opportunities and career development (Bitsch *et al.*, 2006), poor working conditions such as number of hours worked a week, and lack of time off (Searle, 2001; Tipples *et al.*, 2004), a poor reputation in occupational health and safety (Bitsch and Olynk, 2008), and competition for the workforce from other industries (Nettle, 2012).

The image of the dairy industry including career opportunities and lifestyle realities influences the quality of staff entering the industry, and whether future generations of farmers choose to return to the family farm. Currently the dairy industry is not promoted in the education sector as a valid career path, and hence able to attract high quality staff capable of leading future dairy industry ICT advancements. Even in the rural areas of Australia, dairy farming is not considered by the education sector as a career path to be aspiring to. 'Education is your way out of the family farm' appears to be more the motto drilled into kids growing up on a farm, and this view therefore means good quality young new people are not attracted into the industry. Interviewed dairy farmers originating from New Zealand observed that in contrast to Australia, dairying in New Zealand is considered to be an acceptable career option, and a way to build up assets. Farm managers in New

Zealand need a university qualification to obtain employment, with this following through as an expectation for the next generation of farm owners, whether it be taking over a family farm, or building up assets via the sharemilker pathway where a person who lives on a dairy farm milking the owner's herd for an agreed share of the profits and, usually, building his own herd simultaneously

The quality of education in the agricultural sector is also of concern. Farmers expressed frustration at the quality of the workforce entering the industry and TAFE level qualification standards in the dairy industry. One farmer indicated his frustration that the government occasionally provided new employees into the industry with a minimal brief couple of days TAFE course and then sent the new employees out onto the farm to work. Another farmer commenting on the poor standard of assessment of a TAFE course he had funded for his employee. The challenge for the industry is that education at a diverse spectrum is required, with basic up skilling level courses required for those entering the industry as well as relevant university level course for those with general dairy farming understanding and experience. At university level, it may be questioned whether the current 'Agriculture degree' is relevant or marketed correctly. One of the rare university graduates interviewed (who plans a robot installation within the next five years), commented that the community around him is surprised he can utilise any of his university education (and he says 'surprisingly', he can), although the fact that he is planning to put robots in in the next five years shows some testament to the degree. Farmers using a high level of ICT identified the need to be able to fix the technology themselves to reduce dependence on the IT farm technology service industry which is very useful with the rural location of farms. If the farmer could service their own robots it would mean the robots could go into more isolated farms as this was identified as a limiting factor by industry in addition to Internet access. From a tertiary education perspective this highlights the need for an agricultural degree to be broadened to include computer and engineering skills.

Tipples *et al.* (2004) and later Timmermans and Wearing (2011) identified young New Zealanders career priorities (high income, job satisfaction, location, a good work-life balance, leadership and career growth opportunities), and identified that agriculture was not attracting these students, or being promoted in high school. Timmermans and Wearing (2011), state the need for a more educated agricultural workforce, and the need for improved integrated and co-ordinated agricultural courses. Dairy Australia (2013b) report that there will be the need for different skill sets to those traditionally needed and valued in

the dairy industry as ICT is adopted. This research supports the literature that agriculture is not seen as an attractive career path, and that the skillset of the future agricultural sector will need to evolve to meet future ICT challenges.

6.2.8 Lifestyle as a priority

The technology we use is for social reasons, because Frank's got two children, he's got a family, his wife's a school teacher and everything else. And with the technology, he knows when he leaves here of a night that the computers are taking care of his pivots. He knows when he leaves the dairy that the computers are taking care of it. [FARMER 20]

The nature of dairy farming means the farm business and personal life are closely integrated. This makes lifestyle a particularly important consideration, with even the location of the business being a lifestyle decision. This research found all farmers interviewed make ICT decisions based on lifestyle factors.

The first priority is to make the everyday farming and milking routine as lifestyle friendly as possible. Dairy farming is a very time intensive occupation, and a large commitment due to the required twice daily milking. Farmers' will use ICT in the shed to improve lifestyle, whether it is for themselves or sometimes their workers. Lifestyle aims include make milking quicker so more time can be spent with the family or to make milking less stressful through automation features such as auto draft. Implementation of this technology may lead to less labour in the shed, so less milkings for any one individual (and hence more time to spend with the kids). Milking times may even be varied to allow an evening meal home with the kids.

The second goal of many farms is to try to implement strategies to allow the family to get away more. With financial pressures, this can be very difficult to justify, and one farm was interviewed where there had not been an off-farm holiday in over 20 years. However other farms are managing the process better and ICT is being actively implemented to enable holiday opportunities through examples such as the installation of systems able to control the paddock irrigator via mobile phone from the holiday house.

Some ICT system initiatives that were installed to create more family time (such as Robotic milkers), turn out to at least in the initial couple of years, to be a backwards step. Robotic milkers require relief staff to have the skillset to manage robots. This skillset is rare in the dairy industry currently due to there not being many robotic milking systems in Tasmania, or in fact Australia. This impacts not just on longer holidays, but the ability to have a

weekend, or even a night off. Robotic farms tend to have a lower staffing rate than traditional farms, which means there are less employees on the payroll to allow for time off. This from a practical perspective means what is installed as a lifestyle decision is not what it turns out to be. This teething problem highlights how important support is for farmers undertaking industry-leading farming practices, and how a support network of government, commercial companies, and farmers is instrumental to continuing momentum in new ICT initiatives due to the industry-wide change both in farming systems and social systems robotics represent. The activity of ringing up and finding support in the industry for some time off seems a simple activity, however a surplus skilled workforce is not currently available due to the small number of robotic systems currently installed in Tasmania. From an industry disclosure perspective, this type of issue needs to be discussed openly with the client when installing robots. The installation of robots is not just a technical event, but has multiple social implications that the industry has a duty of care to advise of.

Mobile phones (and smartphones) have created real lifestyle gains through shifting business phone calls to during work hours. This has enabled evenings to be spent with the family rather than on the phone. Additionally from a social aspect, they have reduced the isolation that is part of farming, with the ability to text, e-mail, phone, and send photos (assuming reception) at any time out on the farm.

The adoption of ICT has been extensively studied in the Information Systems (IS) discipline, however these models (Ajzen and Madden, 1986; Ajzen, 1991; Davis *et al.*, 1989; Davis, 1989; Venkatesh *et al.*, 2003) do not factor in lifestyle or family priorities. In the agricultural sector it has been recognised that the informational, behavioural and social aspects of decision making have been largely ignored (Tey and Brindal, 2012), with studies seeking to classify farmers on combinations of attitudes, farming practices and structural-demographic characteristics such as those described by (van der Ploeg, 1985; van der Ploeg, 1995; van der Ploeg, 1994; Leeuwis *et al.*, 2004; Roep and de Bruin, 1994; Mesiti and Vanclay, 1997; Howden *et al.*, 1998) among others, and summarised by Csoto (2011). This research supports the agricultural literature that lifestyle is very important in decision making on the family farm.

The older generation of farmer may be motivated to use ICT in the shed or on the farm for a multitude of reasons. ICT in the shed allows them to stay involved in the farm when they are not physically as capable anymore, or may wish to stay involved, but are not interested in milking every day. Assuming the farmer is comfortable with 'trusting' the ICT, the ICT

provides information on individual cows that allows individual cow management 'as if the farmer were actually there milking twice a day and seeing them'. ICT proves a mechanism for older farmers to get a new challenge out of dairy farming, and hence maintain an interest. The utilisation of ICT allows the physical work to be done by staff, and a new side of dairy farming, which has never been explored before – what each individual cow is doing provides a new dimension.

Lifestyle includes personal challenge incentives. Robotic milkers were installed due to a personal challenge desire by the respective farmers and an aspiration to do things differently, with a long-term vision to a changed life on the farm. The style of farmer that enjoys a challenge has been identified extensively in the literature (Roep and de Bruin, 1994; Mesiti and Vanclay, 1997; Vanclay *et al.*, 1998; Waters *et al.*, 2009; Rogers, 1995; Rogers, 2003), and is supported by this research. The literature is divided over age being a factor in ICT adoption. Society stereotypically considers age a barrier, as does some literature. Alvarez and Nuthall (2006), industry reports ACMA (2013a) and models such as UTAUT (Venkatesh *et al.*, 2003) considered age to be a factor in ICT uptake. However Rogers (1983) did not list 'age' as having a positive relationship, finding no consistent relationship. This research found age to have no relationship with the adoption and use of ICT, finding farmers of all ages used ICT if there was a reason to do so.

6.3 CHAPTER REFLECTIONS

This chapter distilled the themes from Chapters 4 and 5 into eight overarching preliminary findings, and discussed these in relation to the available literature.

The next chapter presents the key findings that have emerged from the integrated interpretation and discussion. The next chapter will provide an interpretation of these key findings and provide a discussion about the significance of these findings in relation to available literature. A discussion in relation to a current Information Systems adoptions model will be presented.

CHAPTER 7 OVERALL FINDINGS OF THE RESEARCH

7.1 INTRODUCTION

This chapter presents the key findings, which emerged, from interpreting and discussing the data in Chapter 6. These key findings are further interpreted in this chapter and discussed in relation to the available literature:

- Section 7.2 discusses the key research findings which emerged from the interpretation and discussion of the research findings in Chapter 6;
- Section 7.3 discusses the research in relation to TAM3, and presents an adapted model;
- Section 7.4 provides a summary reflection of the chapter.

7.2 RESEARCH KEY FINDINGS

This section presents the key findings from this research that were developed from the interpretation and discussion of the research findings in Chapter 6.

7.2.1 All generations of farmers are receptive to or using smart-technology due to ease-of-use characteristics (KF1)

This research has found that the introduction of 'smart technology' now means that ICT is easy to interact with, and lack of 'ease of use' is now not considered to be a barrier to use. Smart technology is integrated into the rural community, changing the way farmers do business on a daily basis. Easy-to-use intuitive operating systems, combined with 'smart technology' has seen a proportion of farmer 'jump' technology stages and demonstrates some previous non-adoption reasons to be not relevant anymore. Farmers may not be comfortable using a desktop computer, however are happy to install and use robotic calf feeders, or fully automated dairies.

Literature has reported the benefits of using Internet and online services (May, 2011; Higgins, 2011), and the importance of rural Internet access (Hunt *et al.*, 2012). Increased

usage has been reported through industry surveys (ABS, 2013; ACMA, 2013b). However there has been little literature discussing the impact of smart technology on the family farm business and family life. There has been indirect discussion of use of mobile technology via literature that has shown increased acceptance of decision support systems when integrated with mobile technology (SMS) (Car *et al.*, 2012).

Telstra reported 99% mobile coverage of the population in 2013 (Telstra, 2014) however this research found that current use of mobile phones, and smartphones is less than farmers wish due to reception issues, with lack of reception limiting farmers' business on a day-to-day basis. Internet access is important to the recent innovation in consumer communication and media devices (ACMA, 2012). Even without optimal reception, mobile phones and smartphones were still being embraced, with farmers adapting the way the phones were being used such as using SMS rather than phone calls. Industry considers the provision of reception and fast Internet vital to ongoing ICT progress and an ability to offer improved services. Farmers' were less critical of Internet speeds and reception, because they did not have a current perceived demand for increased services.

Industry reports that farmers lack computer skills, and lack of ease of use is a barrier to adoption. This research found all generations of farmers using smartphones and tablets, with older farmers sometimes having not ever used the desktop, and migrating straight to a tablet. This research found farmers who preferred not to use desktop computers were receptive to investment in dairy related ICT such as automated dairying systems, robotic calf feeders, and used this ICT. Literature is conflicting over whether the inability of farmers to use ICT has been overcome. This research supports that of Gelb and Voet (2009) who believe it has – at least by the innovators, the early adopters and the early majority (see Rogers (1983) terminology). This research finds the farmer characteristics (age, experience, personality, education) listed by Csoto (2011) do not influence the use of ICT.

Females in the family partnership have a strong influence on the ICT use on the farm – particularly in regards to mobile technology such as mobile phones, smartphones, and mobile Internet usage due to their influence on purchasing decisions and also provision of assistance in use. This confirmed the influence of the family in ICT to be important, and highlighted the difference of a 'family farm business' over a 'business'. A gender influence is accounted for in the user acceptance model UTAUT (Venkatesh *et al.*, 2003), but gender is not considered in agricultural adoption models (Alvarez and Nuthall, 2006; Apps and Idding, 1990; Csoto, 2011).

7.2.2 Farmers place a high priority on lifestyle and family when making information and communication technology decisions (KF2)

This research found family and other personal priorities (lifestyle) to be very large considerations when making Information Communication Technology (ICT) investment and usage decisions on the farm. Lifestyle priorities changed over the lifetime of the farmer, and were varied and personal. Lifestyle priorities included the desire to stay on the farm (older generation); Increased time with the kids; ensuring there was a life outside the farm (unlike the parents); to keep the farm challenging and interesting, and to attract the next generation back onto the farm.

The lifestyle consideration occurs in multiple layers within the family farm, with all members of the family being contributors. Whilst the family member(s) physically working on the farm are first thought of when considering 'work-life balance', this finding is also equally applicable to other family members. When ICT use on the farm is increased, an indirect benefit can be increased involvement in the farm by other members of the family, such as the children taking an interest in interpreting the animal health and production data coming out of the milking shed. This provides a positive interaction between the family and the farm business, reinforcing the 'family farm' culture, which ultimately is a lifestyle choice.

ICT is used to make lifestyle choices with the aim not only to decrease the physical time spent on farming activities, but also to change the feeling about these farming activities. ICT is also used to stay interested in the business – as a new challenge, thereby influencing the farmers' attitude towards the farm, and influencing the 'work-life' balance priorities. Lifestyle choices can be made with employee benefit in mind. If farm owners regard their Lifestyle priorities to be important, a good employer recognises farm staff have their own lifestyle (work-life balance) preferences and makes allowances. Farmers were found to have largely differing perspectives on how important their employee's lifestyle preferences were. Industry considered farmer ICT use to be increasing due to a necessity to increase efficiency and reduce costs. Farmers preferred to express themselves in lifestyle choices rather than identify with financial benefits of ICT directly.

The literature identifies the need to understand the human factors in the adoption of agricultural research (DAFF, 2007), and recognises that diversity has not been fully

considered (Vanclay *et al.*, 1998). There has been considerable literature on farmer typologies to better understand and describe the diversity of farmers values, attitudes, behaviour and socioeconomic circumstances in rural communities (van der Ploeg, 1994; van der Ploeg, 1985; van der Ploeg, 1995; van der Ploeg, 2000; Vanclay *et al.*, 1998; Howden *et al.*, 1998; Mesiti and Vanclay, 1997; Roep and de Bruin, 1994; Glyde and Vanclay, 1996; Howden and Vanclay, 2000; Thomson, 2002; Mesiti and Vanclay, 2006; Noe and Alroe, 2003; Thomson, 2001a; Rogers, 2003). These methods vary according to the theoretical approach used and the purpose of the research and have been developed in the agricultural setting primarily to assist in the design, delivery and monitoring of publicly funded policies and programs, in particular to improve the efficiency of extension programs. There is considerable debate about the legitimacy and relative utility of studies centred on the analysis of the adoption of innovations as the basis for generating landholder typologies (Emtage *et al.*, 2006).

Family considerations are very important to farmers. The literature has described the family farm lifecycle (Symes, 1972), and this specifically in relation to cyclic innovation pressures and unique family farm priorities (Errington and Gasson, 1993). The family farm has changed, and there is now less family labour available. The advantages of capital expenditure on machinery to remove family labour constraints was pointed out by Orwin (1930). This advantage is paralleled 80 years later with ICT. Management strategies have also been linked in with family farming priorities (Fairweather and Keating, 1994; Brodt *et al.*, 2006).

The adoption of ICT has been extensively studied in the Information Systems (IS) discipline, however these models (Ajzen and Madden, 1986; Ajzen, 1991; Davis *et al.*, 1989; Davis, 1989; Venkatesh *et al.*, 2003) do not factor in lifestyle or family priorities. In the agricultural sector it has been recognised that the informational, behavioural and social aspects of decision making have been largely ignored (Tey and Brindal, 2012), with studies seeking to classify farmers on combinations of attitudes, farming practices and structural-demographic characteristics such as those summarised by Csoto (2011).

7.2.3 Fragmented ICT investment is detrimental to long-term ICT utilisation (KF3)

This research found that fragmented adoption of ICT systems in dairy farming creates long-term adoption problems, slowing down rates of ICT adoption, due to farmers having

problems figuring out how to integrate different systems. The literature supports that computerised information systems should be fully integrated to ensure a coordinated execution of dairy farming activities (Pietersma *et al.*, 1998), and recognises that software compatibility is of concern for farmers (Kutter *et al.*, 2011). However when factors affecting ICT adoption in agriculture are considered, (Csoto, 2011; Alvarez and Nuthall, 2006; Taragola and Van Lierde, 2010; Apps and Idding, 1990) compatibility and the effect of fragmentation are not considered. In fact Vanclay (1992a), suggested that divisibility of an innovation leads to increased adoption, with the farmer being able to adopt parts of an innovation that are consistent with their farming objectives. This adoption increase would only be where systems have no requirement to be integrated together.

Farmers had difficulty combining existing ICT; resulting in reduced utilisation, finding that compatibility issues were confusing, troublesome and took significant effort to resolve. In the irrigation sector, independent consultants are available to investigate the best system for an individual farm. This same service but for ICT systems and integration, would be of great benefit to the dairy sector. There is a lack of easily available independent ICT advice to navigate the multiple systems available, and the combining of new and older technology, Farmers' historical strengths lie in solving physical problems, and ICT compatibility issues and challenges with the best software to use problems generally fall outside the scope of farmers' skillsets. The solving of ICT compatibility issues was often too difficult. Dairy Australia (2013b) suggested with advancing technologies there will be a need for different skill sets to those traditionally needed and valued in the dairy industry. Solutions to fragmented adoption problems include a differing future farmer skillset, addressed through a change in agricultural education to include ICT specific training; industry making systems more compatible due to consumer demand; industry recognising the need for a specialist in integrating fragmented systems; or due to lack of compatibility between alternative systems, it is recognised systems must be put in as a whole.

7.2.4 Globalisation of ICT use changes farming communities and farming practices (KF4)

Globalisation is a product of the digital economy. Current utilisation of the Internet by farmers and their suppliers has led to dynamically different technical influences compared to the past. Farmers are able to source technical assistance, research and purchase equipment online from global sources as well as domestic. This sourcing of information

and buying of products globally has changed the dynamics of the local rural support industry.

The impact of ICT to the rural community is significant in Tasmania. Farmers' relationships with the local community have changed, with reduced reliance on local advice and support. Industry has found farmers come to them more knowledgeable about the options having researched details online. Farmers are less reliant on the local community for information, sourcing of products, and technological support. The utilisation of ICT; and the globalisation of farmers 'world' has enabled the 'average' farmer to be less constrained by the services and products offered by the local community, and enabled them to shop and source product more easily from outside their normal network.

The literature has recognised the importance of the Internet and therefore access to social media for innovation and information exchange in rural areas (Higgins, 2011; May, 2011; Hunt *et al.*, 2012). However ICT influences are not being incorporated into rural research design Dharma *et al.* (2012) recently conducted a study on sources of information specifically used by farmers, and did not include ICT methods. Yet this research found farmers were utilising the Internet to research purchases, make purchases, and source information.

The utilisation of ICT by farmers has enabled technologically advanced products to be installed on farms with reduced the need for specialist support infrastructure. This has allowed Tasmania to implement technology that would not otherwise be realistically achievable. Continued improvements to ICT infrastructure is required to ensure ICT uptake by farmers continues.

The globalisation ICT provides has provided farmers with direct access to technical assistance from specialist support, bypassing local networks. The ability to put technologically advanced shed into rural areas depends on this ability to provided technological support from a distance, and purposely bypasses local support networks due to the impracticality of maintaining a specialist locally. This is significant in Tasmania with the small number of farms, as farming areas are spread throughout the state. ACMA (2012) found 73% of Internet users went online more than once a day, indicating how important online access has become. Farmers are utilising ICT to become empowered in farming technology and general topics of their interest.

7.2.5 Industry has a key role to play in farmer-focused education on robotic systems (KF5)

This key finding identified that it is equally important for the industry to address the concerns of the general dairy farming community in relation to robotic milking systems as it is to carrying out research to assist current robotic farmers. To this point, industry and academic focus has been on supporting current farmers using robotics rather than the dissimulation of knowledge particularly in regards to pasture management when milking with robotics to the wider dairy farming community. The general dairy farming community requires a better understanding of how the use of robots changes the human-cow relationship in a positive manner, and that time is still spent with the cows. A greater understanding of how the ICT systems fundamental to robotic herd management work is also required and this would enable trust in ICT systems. Components of the academic research community actively involved in robotic milking systems, consider these fundamental farmer concerns to be ‘uneducated’ and therefore not worth addressing. The robotic milking research community is focused on operational components such as grazing management strategies to improve cow flow.

While the international community is able to provide ICT specific technical support, this research identified that there is still substantial need for Australia-specific local support and provision of extension in the grazing management of robotic milking systems. This skillset is not available from milking machine manufacturers as the machines were originally designed for European barn systems, which are non-grazing in nature. The lack of pasture grazing knowledge by farmers was found throughout interviews to be a reason for not implementing robots on more farms.

This study was conducted at the stage of adoption in Tasmania when the number of robotic farms was about to double, providing the opportunity to gain increased understanding of adoption considerations. The farmers’ reasons for investing in AMS have been well documented (Kerrisk and Ravenhill, 2011; Kerrisk and Ravenhill, 2010; de Koning, 2010a) and examined in this research. The research supports the findings of de Koning (2010a) that the topic of AMS or Robots is very much talked about by the general dairy farmer population. The suggestions of Eastwood and Kenny (2012) and Jacobs and Siegford (2012) that the complexity of pasture management in a grazing situation is currently having a negative influence on farmers’ decision to choose a robotic milking system are also important. There has been little mention in the literature of farmer concerns over reduced

contact time with their cows because of the implementation of a robotic system or of lack of trust in the robots to manage cow health and welfare. More social research and education is needed to understand how the farmers' relationship and concern for cow wellbeing influences their decision whether to implement an AMS system.

7.2.6 Summary of key findings

The utilisation of ICT by farmers, and these key findings are reliant on the dairy farmer having access to Internet access, both mobile (for use on a smartphone), and also fast fixed access such as the NBN. Without the infrastructure being provided, ICT will not be used on farm. Few farmers interviewed had the understanding of why Internet speed would be important in the future, however industry considered it essential for their vision of the future, and to allow increased ICT on the farm so the farm is not 'left behind'.

- *KF1 All generations of farmers are receptive or using smart-technology due to ease-of-use characteristics;*
- *KF2 Farmers place a high priority on lifestyle and family when making ICT decisions;*
- *KF3 Fragmented ICT investment is detrimental to long-term ICT utilisation;*
- *KF4 Globalisation of ICT use changes farming communities and farming practices;*
- *KF5 Industry has a key role to play in farmer-focused education on robotic systems.*

7.3 MODEL DEVELOPMENT

This section will discuss components of a proposed model based on the research conducted in this thesis. Through a review of Information Systems models (section 2.5) TAM3 (Venkatesh and Bala, 2008) was considered as the most appropriate and best theoretical lens for this research. The selection of TAM3 is discussed in section 3.10.

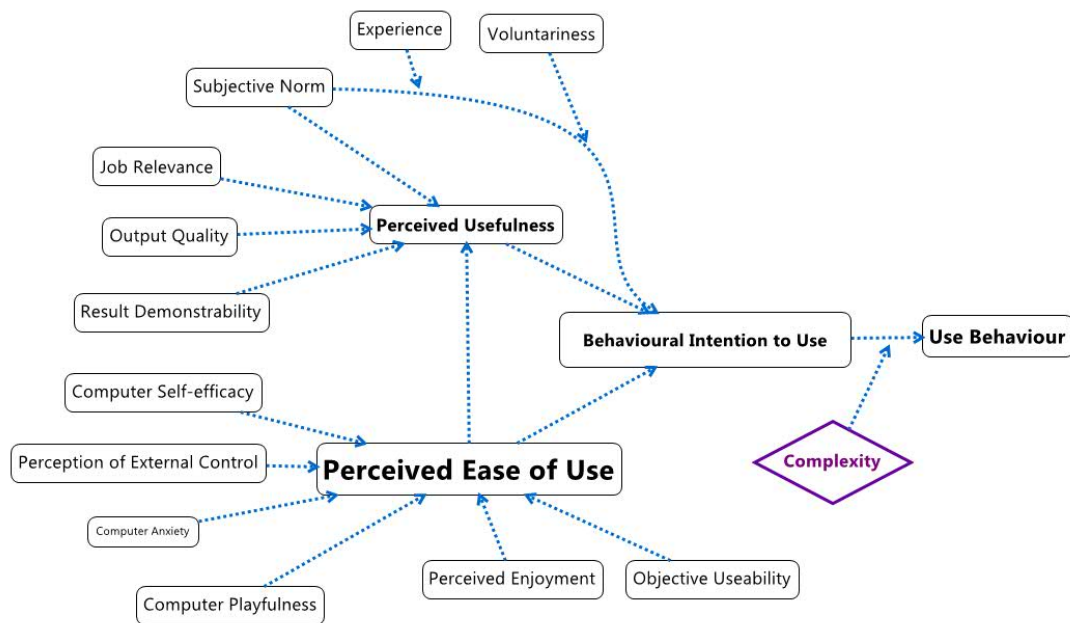


Figure 7-1 Proposed adapted TAM3 model based on research

Perceived Usefulness

“The extent to which a person believes that using the system will enhance his or her job performance” (Davis et al., 1989).

‘Enhanced job performance’ in an agricultural industry such as dairy farming may have the definition of a social or business perspective due to the farm and personal life being interrelated. This means Perceived Usefulness may be ‘ability to keep in contact with mates while bringing in the cows by using a mobile phone’, or contrastingly ‘reduced milking times through adoption of some ICT’. ‘Perceived Usefulness’ may also be a combination of business and personal, which combined provides a more compelling ‘usefulness’ perception.

For ICT to be perceived as useful, the farmer must have confidence that the technology will provide a satisfactory level of information, perform a task, or that backup warning systems are effective. Some farmers do not have this level of trust in technology, believing human interaction is the best option. These farmers do not consider the ICT to be a ‘tool’ that can be integrated in current management practices to provide extra information to assist in management decisions. The Perceived Usefulness of a piece of technology is influenced by physical factors experienced that limit the actual usability of the technology. The Perceived Usefulness of a smartphone is tempered by previous experiences of reduced durability and reception issues resulting in functions such as Internet not being available on the phone

when out on the farm. Perceived Usefulness is also goal orientated. A farmer close to retirement may never have looked at integrating technology into the farming system, and had minimal exposure by choice to ICT. However with a personal goal of wanting to stay on the farm instead of retire, the Perceived Usefulness of ICT is changed.

A farmers' decision to adopt ICT is ultimately goal driven. These goals, may be 'improved financial situation' orientated, however being a family farm, the goal may equally be lifestyle focused, such as 'spend more time with the kids', or 'stay on the farm in retirement'. These overarching goals are not directly technology related, but are the motivator to technology adoption with the recognition of the benefits that adoption of ICT may bring. The achievement of this goal may be reached with the adoption of more than one piece of ICT.

7.3.1.1 Subjective norm

"The degree to which an individual perceives that most people who are important to him think he should or should not use the system" (Fishbein and Ajzen, 1975; Venkatesh and Davis, 2000).

A family farm business by definition consists of a 'management team'. Members of the management 'team' can influence the ICT use of others. This is particularly the case with family farm businesses where the personal and work relationships are intertwined. Particularly for smaller ICT investments such as the adoption of smartphones, one member of the family may have a significant influence of the purchase, setting up and utilisation. The mobile technology also provides the opportunity for social pressure in that 'my mates are using it', encouraging the adoption of the ICT because everyone else is using it. The impact on larger investments such as herd management software combines with shed ICT is dependent on the relationship with the local supplier. For farmers who are reliant on their local supplier for advice, this variable is important – a trust factor is implied here for initial investment. Other farmers do not have this relationship with local ICT representatives, and will do their own independent research as to what is the best system for them. In this case social norm is not a factor.

Both industry funded consults via a farmer levy and private consultants influence social norm. Private consultants are paid to give individualised advice, and as such have a greater influence. Industry funded dairy extension activities such as those run by the Tasmanian Institute of Agriculture (TIA) are more generalised, and require the farmer to adapt the general concepts to their individual farming situation. Other farms do not interact with

consultants in a structured format, preferring to do their own research independently. With these independent farmers, subjective norm is less significant.

7.3.1.2 Changes in social influence with Experience

This component is demonstrated by farmer behaviour. With a new system, farmers actively investigate how the system works, talking to other farmers and consultants. As familiarity with the system grows, farmers' themselves become experts in their new system and provided assistance to other farmers requiring help.

7.3.1.3 Image

"The degree to which an individual perceives that use of an innovation will enhance his or her status in his or her social system" (Moore and Benbasat, 1991).

The role of image is not significant in the agricultural environment. Each farm is unique for its individual characteristics, and has a different family management structure, and lifestyle goals. Farmers are often independent because of their social and historical circumstances. Their position is related to the nature of farming and the fact that farmers work independently in often remote locations for the majority of their work. There was no evidence of adoption of ICT for personal image reasons. For this reason, image is not a component of the revised model.

7.3.1.4 Job relevance

"The degree to which an individual believes that the target system is applicable to his or her job" (Venkatesh and Davis, 2000).

Job relevance is essential to ICT being used in a family farm environment. Because of the small size of family farm businesses, those making the investment and strategic decisions are either those using the system, or those who have a significant influence in ensuring a system gets used (direct contact with employees). For ICT to be perceived as useful, it must do the job better, make the job easier, provide information not otherwise available, or allow the farmer to focus on personal 'social' goals. Job relevance in the use of mobile technology is particularly social in nature.

Job relevance has the significant 'lifestyle' motivator that farmer's make decisions based on, and is therefore a motivator in adoption. If the ICT detects when a cow is on heat

reliability, the farmer does not have to be in the shed at mating time, and can leave others to do the mating.

7.3.1.5 Output quality

“The degree to which an individual believes that the system performs his or her job tasks well” (Venkatesh and Davis, 2000).

Data output quality is fundamental to ICT adoption by farmers. A herd management system that easily produces reports that summarise collected data usefully, will encourage use, including the prioritisation of ensuring data goes into the system. The ICT must collect the right information accurately for an informed decision to be made. Good software design of herd management systems is vital to enable the easy analysis and interpretation of the large amounts of data that are collected each day. ICT will not be considered unless the right data is able to be collected to make an informed decision. Specific herd management software packages are generally installed by default with their respective physical dairy shed milking plants. How good this software is (output quality) influences the use of the system features of both the physical shed as well as the herd management software. It is possible to choose a different software package to ‘run’ the shed, however this requires a level of proactivity that the majority of farmers do not utilise. Most farmers do not realise the use of different software is possible.

One of the reasons to use ICT by the farmer is a lifestyle desire to not have to be physically present to milk the cows twice a day. This can be achieved by either robots that take over the milking totally, or by installing ICT to give the farmer confidence that others can milk the cows without the farmer having to be present. This factor takes into account that the farmer needs to believe or trust that the system is capable of doing this. This research found examples of farmers across the spectrum. Some farmers did not trust the ICT to manage milking of the cows, and hence the animal health components such as detection of mastitis; reproductive management (detecting when to inseminate the cow); and picking up when a cow was ‘off colour’ (detected automatically by decreased milk production for example). This lack of trust meant ICT was not installed or utilised. Other farmers embraced ICT for the ability to do the job required, meaning employees could milk the cows, resulting in their lifestyle goal being achieved such as not having to milk cows, and therefore spend more time with the family.

7.3.1.6 Result demonstrability

“The degree to which an individual believes that the results of using a system are tangible, observable, and communicable” (Moore and Benbasat, 1991).

Because of the small business size associated with family farm businesses, the ‘feedback’ loop of whether a system is working is very quick. If a system isn’t working often the person using the system is the farmer who is making the decisions. Due to the investment cost putting in some systems, farmers will persevere and try to work out a solution if problems do arise.

ICT is employed by farmers to do a job to make their life easier, act as a ‘fail safe’, or to do a better job. Features built into herd management systems can take extensive time to learn depending on the usability of the system. While systems may be capable of providing additional management related information, such as reports on production, and reproductive management, these reports must be easily navigated and at least commonly referred to reports fairly ‘automated’ in production. In addition data collection must be automated as much as possible, with this being a main factor in a farm continuing to use a specific herd management system. With so much data now being able to be collected during milking, the ability of the software to sort through the data and automatically create reports highlighting the important components is vital to avoid ‘information overload’. This assists the farmer to make informed timely decisions based on the important relevant data.

Perceived Ease of Use

“The extent to which a person believes that using the system will be free of effort” (Davis et al., 1989).

There is a positive attitude towards the ease of use of ICT from all generations of dairy farmers. Farmers have an overall confidence that an ICT system can be learnt if required. The older generation prefer to defer to the younger generation given the choice, however are capable of dealing with the ICT if required. Farmers from all generations were found to be adopting herd management and linked milking shed ICT, from ‘scratch’ in some cases by the older farmers. Those farmers adopting tended to be older farmers because the financial resources were available.

Perceived Ease of Use is influenced by the support structure surrounding the 'decision maker' (although family farms generally make their decisions as a 'family'), with family farms being 'partnerships' at a minimum, depending on whether multiple generations are involved. In a 'partnership' stereotypically, but not always, the female is better with ICT, and sorts out the ICT 'problems' or 'issues'.

7.3.1.7 Computer self-efficacy

"The degree to which an individual believes that he or she has the ability to perform a specific task/job using the computer" (Compeau and Higgins, 1995a; Compeau and Higgins, 1995b).

This variable has a very strong influence on Perceived Ease of Use. Farmers have the confidence (self-belief) that they can use any ICT required if there is a reason to do so. The integration of ICT into society and the increase in usability of operating systems, software, and hence hardware such as touchscreens has all contributed to this. The use of smartphones on an everyday basis for social reasons means that the farmer has confidence to install an app, which helps with the business. The use of a smartphone gives the farmer the confidence to transfer this knowledge to other aspects of ICT. The strong support network strengthens this self-ability belief in a family farm business. Other members of the family are available to assist and job share or up-skill as required.

7.3.1.8 Perception of external control

"The degree to which an individual believes that organisational and technical resources exist to support the use of the system" (Venkatesh and Davis, 2000).

The agricultural industry has a good support structure in the use of individual ICT systems sold as an integrated unit, with the cost of this being integrated into the price of the system to offer 'free' support. This support assists the farmer in the belief of ones self that a specific ICT system can be used. Industry offers support in many medians including discussion groups, informal neighbour support groups, phone, Internet, and e-mail support.

Physical distance to technical assistance is a reason why industry may not offer certain ICT to a farmer (such as robots), or a farmer may choose not to install a milking shed containing all the latest ICT. The fixing of mechanical problems with a basic shed is considered to be a skillset easier to source locally if required than some ICT technical problems that may be encountered with a shed with has significant ICT integration. Another restriction to the

offering of technical resources is access to fast Internet. Some software problems can be fixed by remote access, however access to fast Internet is limited in regional areas in Tasmania. Ready access to fast Internet will increase the use of ICT in rural areas due to increased support as well as service accessibility.

Some farmers by up skilling manage the need for external expertise. Robot farmers are encouraged by industry to go overseas and attend technician courses. The agricultural industry has recognised that the future dairy farmer will require a different skillset to mitigate this factor in the future.

7.3.1.9 Computer anxiety

“The degree of ‘an individual’s’ apprehension, or even fear, when she/he is faced with the possibility of using computers” (Viswanath, 2000 p. 349).

This variable is no longer a significant influence in Perceived Ease of Use for dairy farmers in Tasmania. Historically the factor of ‘age’ can be accounted for by this component. Age does not significantly influence the use of ICT on dairy farms in Tasmania. This research found dairy farmers who use a highly automated dairy are just as likely to be close or past retirement as a younger farmer. Farmers believed it was possible to learn an ICT system if required, there just had to be a reason to do so. The ‘farmer’ in this instance is taken as a combined ‘husband and wife’ team.

7.3.1.10 Computer playfulness

“The degree of cognitive spontaneity in microcomputers interaction” (Webster and Martocchio, 1992).

Computer playfulness is a major factor in mobile technology such as smartphones. Farmers have the smartphone on them all the time providing the opportunity for regular interaction with the ICT, which is enhanced with regular phone calls and text messages. Any downtime such as while following the cows on the bike to the milking shed, twice a day, up to an hour each time, the mobile phone is available to inform the farmer on issues such as the weather, new emails, to make a phone call, send text messages or do research on the Internet. This phone interaction is possible even without reception or Internet access, through the ability to take photos, which can be sent later once mobile reception is available. Having access to the mobile phone while out on the farm allows the ability to

take photos for personal reference or to seek assistance on issues such as ‘obtaining information about a weed.

At home, the spontaneous use of mobile technology such as smartphones and tablets continues particularly if Wi-Fi is available, due to the convenience compared to the location of a desktop computer. Spontaneity is also a factor with desktop computers, particularly at night, when the farmer will sit down and ‘play’, whether this is checking the weather for the next day, or personal use, such as downloading music, surfing the Internet, or checking online discussion groups. Depending on the age of the children, Internet use either happens after the children have gone to bed, or older children may be asked for help with how to do things.

7.3.1.11 Perceived enjoyment (Adjustment)

The extent to which “the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use” (Viswanath, 2000 p. 351).

This is a characteristic of the system, in how enjoyable the system is to use. Agricultural systems tend to be fairly ‘functional’ however the opportunity to ‘play’ with data collected does interest some farmers, and is conceptually of interest to the ‘next generation’ of dairy farmers who are university educated and interested in manipulating and interpreting data. Herd management systems that are designed to enable this easily are perceived ‘enjoyable’ to use.

7.3.1.12 Objective useability (Adjustment)

A “comparison of systems based on the actual level (rather than perceptions) of effort required to completing specific tasks” (Viswanath, 2000 p. 350-351).

This variable considers how easy the specific ICT system is to use in the long term. Due to the amount of money a farmer has individually invested in an ICT system, farmers will persevere with a system or delegate someone else to use it. Research is done by the farmer before investing in ICT programs. The research of the farmers includes finding out how easy a system is to use long-term through extensive market research and talking to other farmers. The industry additionally has ongoing support available to farmers. The consumer drives improvements in usability. Useability is a key factor in system design in the agricultural industry because farmers are perceived to have low computer skills.

Duplication of systems or having to double input data because of system incompatibility is a factor the industry needs to address, as this influences the long-term usability of a system. Farmers lose interest in continuously entering duplicated data. Systems that collect data automatically or require regular inputs, such as having to enter that the cow has calved at the time of milking rather than being able to put off the data entry, are considered more useable.

Behavioural intention to use

Behavioural intent is defined as 'the degree to which a person has formulated conscious plans to perform or not perform some specified future behaviour' (Warshaw and Davis, 1985).

7.3.1.13 Voluntariness and social norm influence on behavioural intent

Society now has expectations of communication via e-mail, text messages, and online sources. From a business perspective, this is even more so the case with milk companies texting and e-mailing milk test results, and having the expectation that herd health data is electronically recorded for auditing requirements. This means in relation to the use of a mobile phone, and computer, there is a mandatory element in the dairy family farm business.

Use behaviour

TAM assumes behavioural intention flows into usage behaviour, however this research has demonstrated this is not the case.

Time is a factor in behaviour. Farmers do not have the capability to employ additional staff to free up time to implement ICT. Farmers are more familiar with physical problems, so will prioritise the 'easy' physical activates over having to 'mentally' sort out ICT factors. The financial position of the family farm is also a factor in whether there is any family farm business intention to use ICT. Even if ICT is perceived to be very beneficial, if the capital investment is more than the farm can afford, ICT will not be invested in.

7.3.1.14 Complexity

This research has shown complexity of integrating systems is a determinant in use behaviour. Farmers have intent to use a system, but when the system is purchased, there are compatibility issues with old systems. Behavioural intention to use may not eventuate in use behaviour due to system constraints that include inability of the system to adapt to

farmer requirements, or incompatibility between new and currently installed systems, particularly in the case of international systems, a system design that does not do everything that farmers in Australia want or wish. This compatibility issue is more prevalent in internationally designed systems.

Smart technology has had a significant positive influence on ICT use. Smart technology has the capability to decrease compatibility problems experienced by the farmer, as sheds become ICT enabled, and Internet connected. This will enable the utilisation of off-site resources over the Internet 'behind the scenes' without requirement of technical knowledge or contribution by the farmer.

Model summary and future perspectives

TAM3 is conceived largely as a framework for explaining decision making by individual persons. However decisions with regard to technology acceptance and actual use are often done collaboratively or with an aim to how they fit in with, or affect, other people or group requirements (Bagozzi, 2007). This is the case in the respect of family farm business in this study. TAM3 considers decisions from an individual's perspective, yet in a farming situation, the family makes decisions, whether this is husband and wife, or an extended family of parents and children. This criticism has been discussed previously (Bagozzi, 2007), and has been demonstrated in this research.

Lifestyle factors were found to considerably influence the use of technology by dairy farmers. This significant finding has been discussed in relation to TAM and an attempt made to deepen TAM3 by discussing the sociological reasons behind variable influences.

The research has put a social perspective on TAM3, and critiqued the relevance of TAM3 to the family farm dairy business in Tasmania. Perceived Ease of Use was found to have an increasing significance in the adoption of ICT. With Perceived Ease of Use being a positive factor, Perceived Usefulness was found to be the deciding variable in ICT adoption. This positive Perceived Ease of Use finding is significant in the dairy industry context with agricultural literature.

This research puts into question the future role of TAM3 as a whole in predicting information technology acceptance and usage. The farming industry has been historically perceived as slow adopters of ICT yet this research found wide acceptance of ICT and a positive attitude towards ICT because of the integration of 'smart technology' into the

everyday life of the farmer. Social aspects and the advent of the smartphone have primarily driven this change. Smart technology has been developed with a focus on reduced complexity. The reduction in complexity has seen with this cohort of people an increase in adoption. This calls into consideration the future roll of TAM3 and resistance to acceptance.

ICT is now perceived easy to use, questioning the usefulness of the 'Perceived Ease of Use' component of TAM3. This research found factors such as the physical time required to research and implement the ICT (incorporating the candidate's proposed 'complexity' component of TAM3), the financial assessment of return on investment of ICT investment, and farmer goals and priorities, particularly lifestyle to be substantial contributors to the use of ICT. Lifestyle priorities are a significant consideration when making decisions on the farm, with this being a difference between commercial companies and family farm businesses. These are to some extent captured through the 'Perceived Usefulness' component of TAM3, which this research has contributed a social perspective to. This research has therefore contributed to TAM3 by adding a social perspective to 'Perceived Usefulness'.

7.4 CHAPTER REFLECTIONS

This chapter has presented an interpretation and discussion of five key findings that emerged from integrating the findings obtained in the previous chapter.

This research found that farmers place a high priority on Lifestyle and Family when making ICT decisions (KF2). All generations of farmers are receptive or using smart-technology due to ease-of-use characteristics (KF1). Fragmented ICT investment is detrimental to long-term ICT utilisation (KF3). Globalisation of ICT use changes farming communities and farming practices (KF4). Industry has a key role to play in farm-focused education on robotic systems (KF5).

This research has put a social perspective on TAM3, and critiqued the relevance of TAM3 to the family farm dairy business in Tasmania. Perceived Ease of Use was found to have an increasing significance in the adoption of ICT. With Perceived Ease of Use being a positive factor, Perceived Usefulness was found to be the deciding variable in ICT adoption. This positive Perceived Ease of Use finding is significant in the dairy industry context with agricultural literature. Prediction factors between 'Intention to use' and 'Usage Behaviour' are discussed, and a model based on TAM3 proposed.

The final chapter of this thesis answers the research questions and outlines the conclusions of this research.

8.1 INTRODUCTION

This final chapter provides a summary of the key findings, answers the research questions and discusses the contributions to knowledge this research has made. Additionally it discusses the limitations of this research and suggests future research directions in this area. The chapter is structured into the following sections:

- Section 8.2 provides a summary of the research findings, and answers the research questions;
- Section 8.3 summarises the contribution to Information Systems knowledge of this research at a substantive, methodological and theoretical level;
- Section 8.4 discusses the implications for industry;
- Section 8.5 highlights and discusses the limitations of this research which includes the scope of research, lack of generalizability and research bias;
- Section 8.6 suggests areas for future research;
- Section 8.7 provides a summary reflection of the chapter.

8.2 SUMMARY OF KEY FINDINGS

This section provides a summary of the findings that were presented in Chapter 7 and answers the research questions and associated sub-questions.

The key findings for the research are as follows:

- KF1: All generations of farmers are receptive or using smart-technology due to ease-of-use characteristics;**
- KF2: Farmers place a high priority on lifestyle and family when making ICT decisions;**
- KF3: Fragmented ICT investment is detrimental to long-term ICT utilisation;**
- KF4: Globalisation of ICT use changes farming communities and farming practices;**
- KF5: Industry has a key role to play in farmer-focused education on robotic systems.**

The aim of this research was to explore the social and technological factors that drive ICT adoption in Tasmanian dairy family farm businesses. The following research question and sub-research questions have been designed to meet the aims and research problem of this study. The research question will be answered by answering the three sub-questions:

RQ What are the social and technological factors that drive ICT adoption in Tasmanian dairy family farm businesses?

RQ sub 1: How do family farm businesses interact with ICT?

RQ sub 2: How do family farm businesses attitudes and experiences influence the uptake of ICT?

RQ sub 3: How is industry influencing technology uptake in Tasmanian dairy farms?

8.2.1 RQ sub 1: How do family farm businesses interact with ICT?

Industry research to this point has shown farmers have been slow to uptake ICT (Gelb and Voet, 2009; Alvarez and Nuthall, 2006; McBratney *et al.*, 2005; Lamb *et al.*, 2008). This research found farmers now have confidence in their ability to use any ICT implemented on the farm, both current and future. The confidence in this ability to use and implement is positively influenced by the ease-of-use characteristics and the familiarity of mobile smart technology. Farmers have been slow to interact with computers to this point primarily for two reasons. Firstly, farmers by nature are ‘hands on’ and practical - more familiar with working outdoors than indoors and ICT to this point has largely required the farmer to be in an office. Secondly ICT until recently has not been easy to use or intuitive. Farmers have adopted smartphones readily for three primary reasons. Firstly, smartphones are easy to use with the user interface being intuitive, with features such as touch screens and context awareness due to geographic information systems for location specific information. Secondly because they offer useful benefits, for example Internet research can be done while out in the paddock, photos of a weed can be taken at the time and immediately sent for analysis, and there is an increased ability to be contacted via phone, text message, and e-mail which is useful for business such as organising contractors during the spring silage making season, and thirdly because their daily routine does not have to be changed to accommodate the use of a smartphone.

The immediate family is a large influence in the uptake of mobile technology with assistance through the decision-making process, implementation and in everyday use.

Other family members such as kids or the wife often get the latest smart phone technology first, and then promote the benefits to the farmer. Because farmers' are 'working' during the day, often the phone and plan is setup by other family members, and then the features and benefits of the smartphone are explained and promoted to the farmer. Apps they believe will be beneficial are installed and then individualised training on the use of these apps and the phone in general are conducted by other members in the family.

The installation of ICT, in particular robots provides the interested farmer with a new level of challenge to milking cows as it incorporates a totally different cow management system. Robots rely on cows coming to the dairy by themselves without having to be physically collected from the paddock. This requires a totally new skillset from traditional farming, such as in increased understanding of cow behaviour or 'cow psychology' to enable an understanding of what will motivate the cows to walk themselves to the milking shed and back. This need to learn new skillsets, and the interest factor of treating cows more as individuals keeps farming interesting for those farmers who need a new challenge.

Dairy farmers in Tasmania are able to install milking sheds utilising extensive ICT because ICT support is available through technologies such as remote access and e-mail both domestically and internationally. The state of Tasmania is physically isolated, with ICT manufacturers generally basing themselves in Melbourne. Farmers within the state of Tasmanian are often geographically isolated further within the state. Farmers are using ICT to gain interstate and international technical support through e-mail and remote access support options to enable installation and use of ICT such as robots and fully automated traditional rotary and herringbone type dairies. While remote access is currently available, the connection speed is limiting with speed improvements essential to support increasing advanced ICT shed installations.

In summary farmers interact with ICT primarily using smart technology with technical support from family members.

8.2.2 RQ sub 2: How do family farm businesses attitudes, and experiences influence the uptake ICT.

This research found farmers' first priority on a farm is physically setting up the farm by fencing and installing irrigation before refinements such as implementing ICT in the shed are undertaken. There is the potential for this to be misinterpreted as 'not receptive',

however this is not the case but rather a reflection of the physical aspects of farming and the practical requirements of running a farm.

The dairy farmer found insights into the factors that prioritised ICT use. Interestingly while economic reasons to use ICT are pushed by the industry, farmers choose to discuss physical, social and personal reasons as motivators to use. This is a reflection of farming being as much a 'lifestyle choice' or 'way of life' as a business, and the result of the family being integrated into farm life, creating unique 'family farm business' ICT priorities. These unique 'family farm business priorities' include lifestyle choices such as spending time with the family, working closer to nine-to-five working hours, and making the work less physical demanding. By installing ICT in the shed the farmers' lifestyle can be improved with less requirement to be in the shed either because less labour is physically required, or because through the utilisation of ICT herd information can be gathered electronically which enables management of the milking herd without physically interacting with the cows at milking. ICT can make farming less physically demanding through not having to manhandle calves (installation of a robotic calf feeder), installation of robotic milkers so the farmer does not have to physically milk at all, or through installing a fully automated shed. Cow management requirements such as drafting out cows can be automated reducing the need to physically climb in and out of the 'pit' where the cups are put on.

An important component of this research was the finding that the uptake and use of ICT by the family farm business occurs at all stages of life due to the unique ICT priorities of each individual farmer. Older farmers are more likely to install ICT into their shed because this means they can still 'manage' the herd without having to physically milk the cows, which provides increased lifestyle choices due to the fact the farmer is not required to be at the dairy shed for milking, but rather be on a holiday somewhere, remotely accessing the computer at home (or in the cloud) to check on the herd. These older farmers look at installing ICT to encourage the next generation back onto the farm.

Farmers' are conducting independent online research both inside and outside the traditional knowledge base of their local supplier. This has changed the dynamics of the supplier-farmer relationship, with the local supplier being utilised less for product knowledge and more for supply. The local supplier may be removed totally, with the product being sourced outside the local area. This relationship is paralleled in the use of technical ICT support, with ICT advisors as likely to be international or interstate.

In summary, ICT uptake is influenced by family and lifestyle priorities.

8.2.3 RQ sub 3: How is Industry influencing technology uptake in Tasmanian dairy farms.

The rural community is reliant on the government and commercial mobile phone companies to provide high-speed broadband infrastructure and improved mobile phone reception to enable continued ICT advancements to be implemented on farm. Currently there is limited mobile phone reception on farms, limiting the opportunity for development of 'cloud' based applications, and the full use of smartphone capabilities such as the use of applications, and instant access to information via the Internet. Fixed Internet speeds limit possibilities for herd management software development, and remote access capabilities particularly for robotic milkers. The industry can see significant future benefits, and software development opportunities but are currently limited by infrastructure (Internet access).

The electronic file format the Australian dairy sector uses to keep cow information is different, and often incompatible with the international format some international companies use. This results in cow data management problems for the farmer and the industry. The outcome is information not being provided to the industry due to either the farmer not being able to export the data from their computer system, or because the farmer stops collecting the information due to the extra time commitment required to work around the problem. Lack of support and transparency of support by some international vendors for the Australian dairy industries requirement for cow information, and for the dairy farmers requirement to transfer information about their herd to industry bodies creates significant problems for the farmer and the Australian dairy industry. Farmers generally do not realise they cannot export data collected on-farm in Australian industry standard format until after the purchase of the milking plant machinery and supplied herd management software.

Lack of independent, non-commercialised information and education on milking with robotics is slowing the uptake of robotic systems. The general farming population is interested in robots, however support for specific concerns such as the different grazing management strategies required; questions over how robotics manage the cows health; and how milking with robotics affects the farmers relationship with their cows is not readily available to the farmer. The farmer making an informed decision initially and receiving

ongoing support influences the successful long-term use of robotics. Currently the practical every-day challenges associated with robots such as ‘who looks after the robots when I go on holiday’ are not necessarily discussed and addressed before installation. Lack of independent advice on robot installations was identified to be a concern for prospective robotic farmers, and needs to be provided by the Australian dairy industry through industry-funded extension organisations or specialist robotic milking systems researchers and extension staff.

In summary, continued uptake of ICT by Tasmanian dairy farmers requires the industry to lobby for continued rollout of the NBN for high speed Internet to rural areas. The industry needs to lobby commercial providers of mobile phone coverage to increase their reception range to enable smartphones to be used on the farm. Incompatibility between internationally designed herd management systems and the Australian systems requires industry intervention to ensure international companies provide software that is compatible with Australian data transfer protocols.

8.3 RESEARCH CONTRIBUTIONS

This section reviews the contributions that this thesis makes to the study of social and technological reasons for ICT use/non-use on family dairy farms. The research contributions can be presented at three levels: the theoretical, the methodological and the substantive level.

8.3.1 Substantive level

At a substantive level this research has provided a rich case study of the use of Information Communication Technology (ICT) on dairying family farm business in Tasmania. Dairy farming was selected exclusively due to the fact that dairy farming is the most intensive of the grazing animal production systems, and therefore it has the most opportunity for ICT to have a significant effect on the industry. Tasmania has the largest average herd size of all the states in Australia. This larger herd size is an indication of the trend Australia wide, and makes Tasmania an industry relevant location to conduct the study (section 2.2.6). Thirty-three small, medium and large (greater than 500 cows) farms were selected from all dairying regions of Tasmania, (Section 3.4.2).

8.3.2 Methodological level

At a methodological level this research contributes significantly in two ways. Firstly historically agricultural as well as broad innovation adoption, acceptance and diffusion research has been predominantly empirical and quantitative in nature (section 3.4.1). This research used a qualitative approach to facilitate a comprehensive whole, or integrated systems understanding of family farm businesses' use of ICT. This recognises the importance of the situational context that surrounds farmers' use of ICT. The view that such research is needed is supported by DAFF (2007) who identified that better understanding of human factors in the adoption of research in the agriculture and food industries is important to ensure intended research and development outcomes are achieved. A review of literature concerning the adoption of ICT in agriculture (section 2.5.2.2) found the majority of the studies to be survey and quantitative in nature (Gelb and Voet, 2009; Alvarez and Nuthall, 2006), which is reflective of broad innovation, adoption, and acceptance and diffusion research. Williams *et al.* (2009), concluded innovation adoption, acceptance and diffusion research over a 22 year period was predominantly empirical and quantitative, revealing clear opportunities for researchers to make original contributions by making greater use of theoretical and methodological variety. Tey and Brindal (2012) reviewed from an economic perspective factors explaining the adoptive decision making of Precision Agricultural Technologies (Table 2-16), and concluded that current models in the approach are not sufficient to represent the totality of those considerations which lead to the adoption of Precision Agricultural Technologies, with past studies largely ignoring the informational, behavioural, and social aspects of decision making. Secondly, industry supporting interviews were used to provide an additional perspective and lens on the research (Section 3.4.2).

8.3.3 Theoretical level

At the theoretical level, this research extends a social perspective on TAM3 (section 2.5.1.3), and critiques the relevance to the family farm dairy business in Tasmania. A model expanding the determinants of individuals IT adoption and use was developed for the agricultural sector (section 7.3). Analysis of the data revealed 'image' was not a determinant of Perceived Usefulness. Additionally the relationship between behavioural intention of use and actual use behaviour was better predicted with inclusion of a complexity determinant reflecting impact of system compatibility.

8.4 RECOMMENDATIONS FOR INDUSTRY

From an Information Systems perspective, there needs to be better integration between ICT systems, specifically internationally designed systems being compatible with Australian data transfer protocols, or alternatively Australia uses international standards. There needs to be increased openness in regards to capabilities of international systems to participate in domestic collection of cow data by international companies. There is the possibility of the Australian industry losing access to large volumes of data otherwise due to cow data being stored in incompatible formats either on-farm, or internationally. The Australian dairy industry including ADHIS, NDHIS, Dairy Australia and state-funded research and extension departments (TIA in Tasmania) need to value add this data, and educate the farmer as to why this information is vital to the domestic dairy industry. This will create a farmer demand for their individual data to be used to assist in 'industry good' activities such as domestic calculation of genetic breeding values. Farmers do not realise their data cannot be exported to domestic systems such as industry body databases until after the system is purchased and committed to.

The role of the education sector in the successful use of ICT on farm is important. Both farm owners and staff require a new skillset, which includes skills in ICT, computing, electronics and engineering, ensuring the next generation of farmer has the capabilities to understand, implement, conceptualise, and fix future ICT systems on farm.

This research has demonstrated that ICT use is of interest to all generations of dairy farmers. A mindset switch is required by the industry to not 'write off' older farmers, but better understand how ICT fits into lifestyle goals. Older farmers are more than capable, and interested in implementing and using ICT, however improved industry support structures will be of benefit.

The industry has significant work to do to support the future of the robotic milking system. This role begins with a role to educate the 'everyday' dairy farmer on the use of robotic milkers in a pastoral system. The industry needs to understand current valid concerns and questions surrounding the use of this technology and implement extension programs. Concerns expressed by dairy farmers, such as reduced contact with cows, needs explaining. Farmer confidence in their pasture management skills needs improving. The industry also has a role and responsibility to provide commercially neutral advice in the decision stage of robot implementation. Currently it is questionable whether prospective farmers have

access to neutral and impartial advice, having to rely on visits to successful robot farms organised by commercial companies. This requirement for practical support continues once a system is installed, with problems such as ‘who keeps an eye on the system when I go away?’ On an animal management and system level, industry representatives such as Dairy Australia and state providers of agricultural extension (TIA in Tasmania) must decide if they are going to provide specialist herd management support for robotic systems, or if this support is going to be provided at a global level by commercial robotic manufacturing companies whose core market is barn-based rather than pasture based robotic systems.

There is a role in the industry for independent advisors specialising in ICT systems. This is due to the complexity of integrating existing and new ICT systems, the number of systems on offer, and the need for independent advice particularly in regards to robotic milking systems. The advisor for the robotic systems must in addition be attune to the impact on the farming family of these systems because of the resulting significant change to the farmers way of life, and the current lack of a practical ‘hands on’ support network. This social and practical every-day level support may equally be provided government or industry level funding such as Dairy Australia, or in Tasmania TIA.

Fast Internet in regional Australia is essential to provide technical support and farm system monitoring of increasingly complex ICT installations in the dairy. The speed of Internet required is not currently available and is therefore a priority. Industry bodies have a role in communicating this on a national level.

8.5 RESEARCH LIMITATIONS

This section addresses the limitations of the research. Inherent within all research methods are strengths and weaknesses and it is important to acknowledge and demonstrate how these limitations have been addressed. The limitations of this research are the scope of the research, the researcher bias and the lack of generalisability.

8.5.1 Scope of research

This research interviewed a small number of dairy family farm businesses in Tasmania, incorporating a cross-section of herd sizes and physical locations. The research was of an exploratory nature aimed to provide insights into the understanding of ICT adoption and use on the dairy farm by family farm businesses. Interviews were conducted with 33 family farm businesses, with six industry contacts enabling an alternative lens. The researcher

gathered sufficient data to develop a model of ICT adoption and use, and to produce lessons for understanding how and why dairy family farm businesses use ICT.

This research is not a longitudinal study and only provides a snapshot of the current activities of a section of family farm businesses. Each farmer was interviewed only once with follow up phone calls occasionally made to clarify any particular points of the interview.

This research did not provide a comparison with other agricultural industries or farming structures. Insight may have been gained through such comparison. This could be the basis of future research.

8.5.2 Researcher bias

Qualitative research is subjective in nature (Denzin and Lincoln, 2005) and hence vulnerable to bias from the researcher. Rather than objectivity, the focus should be on fairness where all possible attempts have been made to have all voices in the inquiry treated fairly and with balance (Guba and Lincoln, 2005). In order to address the issue of researcher bias in this case study research, Lincoln and Guba's trustworthiness criteria of credibility, transferability, dependability, and confirmability (Lincoln and Guba, 1985) have been applied (section 3.8).

The credibility of this research is provided in the research design. Lincoln and Guba (1985), refer to the researcher having an extended time in the field with persistent observations to ensure credibility. The design of this research (see 3.5) was based on the researcher interviewing a large number of dairy farmers to capture the diversification and uniqueness of farmers as individuals. In addition, qualitative research may involve the researcher using their own experience to bring out the meaning of the data (Strauss and Corbin, 1998). Therefore to address possible researcher bias and ensure credibility the rich description produced from farmer interviews was provided with an alternative lens of industry interviews. This alternative lens provided triangulation and "may well prove invaluable in order to check that supplied by the users, to help explain their attitudes and behaviour and to enhance the contextual data relating to the fieldwork sites" (Shenton, 2004 p. 66).

In order to achieve transferability researchers are required to gather sufficient data for the readers of the research to draw comparisons to other contexts, if so desired (Bradley, 1993). Every effort has been made to provide the thick description necessary to enable the reader to make a decision as to whether transferability is a possibility (Lincoln and Guba, 1985) by conveying to the reader the boundaries of the study as described by Shenton

(2004). The research design has provided the reader with two alternative lenses – farmer and industry.

The dependability of this research is provided through the clear and detailed methodology detailed in Chapter 3. The use of multiple collection techniques and sources throughout the research adds to the dependability of this research. The data analysis, outlined in section 3.7 was applied separately to the alternative farmer and industry lenses before moving to the integrated interpretation and discussion.

The concept of confirmability is the qualitative investigator's comparable concern to objectivity, referring to the degree to which the results can be confirmed or corroborated by others. Farmers and Industry have provided the confirmability of this research with the thesis providing a rich description of the industry and its practices. Ajzen (1991), considers that a key criterion for confirmability is the extent to which the researcher admits his or her own predispositions. The researcher has worked in the Dairy Industry in Australia for ten years in a commercial context as well as in an industry and government funded research capacity. Due to the researcher's extensive industry knowledge, and hence the opportunity for the researcher to introduce bias into the research, a rigorous grounded data analysis approach was followed to restrict inadvertent researcher bias.

8.5.3 Lack of generalisability

The lack of generalisability is one of the major limitations associated with case study research. This research may provide some generality to other similar agricultural or horticultural businesses or family run businesses as the findings are presented in a manner that supports the reader assessing the potential transferability to their own setting (Huberman and Miles, 1994). It will be left to those businesses to determine the generalisability of the findings of this research to their own business.

8.6 FUTURE RESEARCH

Given the relatively small body of qualitative research in the area of social and technical use of ICT on farms, there is a great deal of scope for future work in this area. In relation to the specific findings of this research, however, there are a number of projects that can be undertaken in the future.

This research has highlighted the importance of lifestyle and family when making decisions. However the importance of lifestyle and family in decision-making on corporate run farms

to the best of the researcher's knowledge has not been researched. Further work exploring the influence of lifestyle and family in a corporate farming setting is relevant to maintaining a happy sustainable workforce. Corporate farms are increasing in number and in size and importance in the Tasmanian and Australian dairy industry.

Similar research in other agricultural and horticultural industries would be beneficial to investigate whether parallels exist. Further multidisciplinary research is also recommended to enable the opportunity of other perspectives and 'cross-pollination' of concepts.

The relationship with ICT on the farm, by farm staff is an area overlooked by research. ICT has the ability to add another dimension to dairy farming, yet the majority of farmers do not incorporate their staff in ICT decision-making. The success of ICT on the farm is related to staff interaction and commitment to the ICT on-farm.

8.7 CONCLUDING REFLECTIONS

In conclusion, this thesis explores use of ICT on Tasmanian family farmed businesses using a qualitative case-study approach. This research presents findings that contribute to an improved understanding of the social and technological factors influencing ICT use. It has highlighted the importance of family and lifestyle in decision-making, and the receptiveness to and extensive use of smart-technology by the farmer due to its ease-of-use characteristics. This research has emphasised the important role industry has in farmer education on robotic milking systems.

This research has made contributions to Information Systems knowledge at substantive, methodological and theoretical levels. At a substantive level, it has provided a case study of ICT use by Tasmanian dairy farmers and relevant industry, contributing to the understanding of factors influencing the use of ICT on everyday activities around the farm. This contributed to the understanding of lifestyle motivators, and the positive effect smart-technology has had on ICT utilisation. At a methodological level this research has made a contribution by conducting a qualitative study of farmers' ICT use to provide in-depth understanding to traditionally quantitatively researched field. At a theoretical level, the research has developed a revised TAM model that improves the explanation of the relationship between intention to use and actual use of ICT.

This research has laid the foundations for future research to occur in the holistic understanding of ICT use in the rural dairy industry.

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APPENDIX 1 : FARMER INTERVIEW

FRAMEWORK

BACKGROUND

- What is the physical size of your farm (ha)?
 - Is farm self-contained feed wise?
 - Supplements (nitrogen, irrigation etc.).
- How many cows do you milk peak season?
 - Are young stock run on or off farm?
- What is the ownership structure of the farm?
 - Manager; partnership; trust
- Who is involved with the family farm business, and what is their role?
 - Family
 - Staff
- How did you come about to be involved in the dairy industry?
 - Formal/informal education
- How long have you been on this property?
 - Past/future farm improvements?
- What are your short and long-term goals for the family farm business?
- Do you anticipate being farming in 5/10 years – why/why not.
 - Family succession planning if applicable.

DISCUSSION TOPICS

- Knowledge growth – Essentially how does one go about finding out information about
 - Management improvements including irrigation, grazing management, staff management, herd management, milking time etc.

- Capital investment choices including irrigation, herd management software, shed improvements/automation, new machinery including tractors etc.
- What investment/management decisions have had the biggest impact on your business
 - Why? What are the factors surrounding implementation
 - Financially
 - Time/family/lifestyle wise
- Use of ICT. Approach here is to systematically work through seasons and ID/discuss
 - What ICT programs are used?
 - Why using? E.g. are the problems solved?
 - What were the main factors influencing use?
 - Why did you decide to use it? E.g. neighbour influence, personal experience of the process working, field-day, researched a problem and solved it or forced to as a regulation
 - Has it met expectations?
 - Problems?
 - Unexpected outcomes?
- What single/combination of above has made biggest impact on farming business e.g. day-to-day running, \$\$, time/lifestyle.
-
- Specific/future technology questions
-
- What future role do you see ICT playing in your family farm business/the Industry in the next 5/10yrs?
-
- Have you heard of X, do you see a place for X in current/future farming environment, is X something that you feel has a place in your strategy for the future? Why/why not, assuming farming into the future is important.
- Do you think robotic milking has a place on the Australian Dairy farm of the future? Do you see robotic milking as something that you would utilise yourself in the future? Why?

CLOSING

- Any needs fixing, needs more work in this area, wish this would be developed/fixed/looked into further?
- What are your thoughts on the future of the dairy industry in Tasmania and Australia?

APPENDIX 2 : INDUSTRY INTERVIEW

FRAMEWORK

BACKGROUND

What is your personal story i.e. career background – understanding their lens

What is your current role/responsibility in the industry?

ICT QUESTIONS

Broadly

1) Future role of ICT in dairy farm

What will the future farm look like in 10yrs?

- What future role do you see ICT playing on the farm in the next 5/10yrs?
- Is on-farm ICT use driven by industry, if so, how
- How does the farm drive development of ICT by industry
- What ICT expectations do farmers have of you?
- How much interaction do you have in relation to ICT with them
- What factors do you believe influence uptake of ICT by farmers
- What do you do to encourage/promote use?
- How do you incorporate their requirements/expectations into your service/product?
- How actively do they seek out ICT solutions to problems
- What is stopping use?
- Where within the farming unit do you believe the drive to adopt comes from?
Does this change?
- How does your organisation promote ICT use on farms?
- Is there anything the industry needs to do?

- Are there any industry problems that need to be addressed to encourage/progress use of ICT by farmers?
- What will drive ICT use by farmers in the future?
- What is the place of internationally developed ICT in the Australian dairy industry?

CLOSING

- Any 'needs fixing'; 'needs more work in this area'; 'wish this would be developed/fixed/looked into further'?
- What role does ICT have in the future of the family farm business?

APPENDIX 3: SEASONALITY OF MILK PRODUCTION BY STATE

Seasonality of milk production by state (million of litres). (Dairy Australia, 2012b)

